



**PLEASE CHECK FOR CHANGE INFORMATION
AT THE REAR OF THIS MANUAL.**

**DC 5010
PROGRAMMABLE
UNIVERSAL
COUNTER/TIMER
WITH OPTIONS**

English only

INSTRUCTION MANUAL

**Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077**


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INSTRUMENT SERIAL NUMBERS

Each instrument has a serial number on a panel insert, tag,
or stamped on the chassis. The first number or letter
designates the country of manufacture. The last five digits
of the serial number are assigned sequentially and are
unique to each instrument. Those manufactured in the
United States have six unique digits. The country of
manufacture is identified as follows:

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NOTE

The following illustrations are located in the diagrams section at the rear of this manual.

OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

In This Manual

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

In This Manual



This symbol indicates where applicable cautionary or other information is to be found.

As Marked on Equipment



DANGER — High voltage.



Protective ground (earth) terminal.



ATTENTION — refer to manual.

Power Source

This product is intended to operate from a power module whose power source will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This product is grounded through the grounding conductor of the power module power cord. To avoid electrical shock, plug the mainframe power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

Use the Proper Fuse

To avoid fire hazard, use only the fuse of correct type, voltage rating and current rating as specified in the parts list for your product.

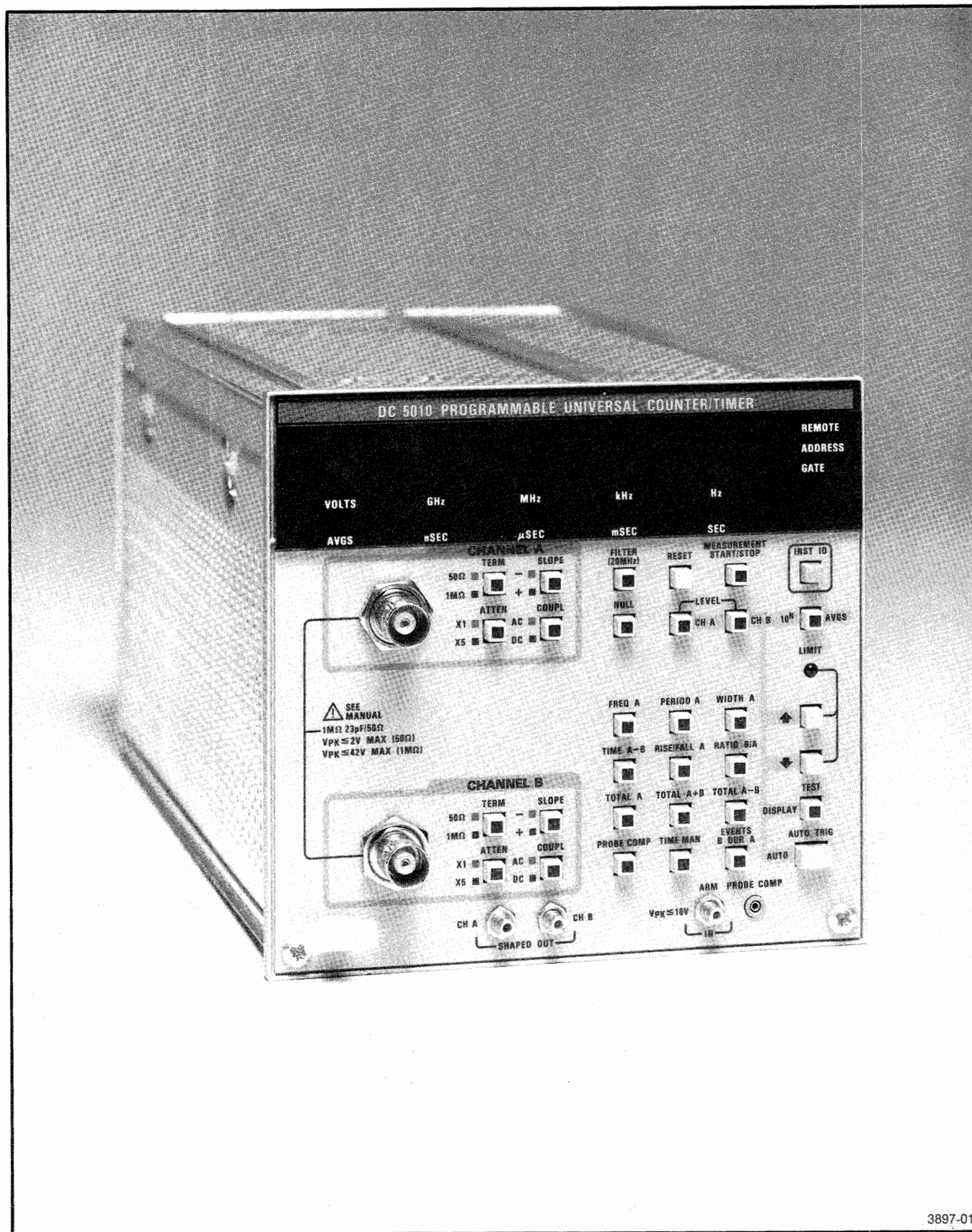
Refer fuse replacement to qualified service personnel.

Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Operate Without Covers

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.



The DC 5010 Programmable Universal Counter/Timer Plug-In Unit.

SPECIFICATION

Instrument Description

The Tektronix DC 5010 is a programmable universal counter/timer plug-in. It features reciprocal frequency, Period, Ratio, and Events B During A measurements to 350 MHz. For timing measurements, the time interval, width, risetime and falltime functions feature 3.125 nsec single-shot resolution. For these measurements, averaging and identical A and B channels provide increased accuracy. Also included is a time manual mode, as well as three 350 MHz totalize modes (A, A+B, and A-B). The DC 5010 also has an auto-trigger feature, a probe-compensation feature, an auto averages function, and an extensive set of automatic power-up self tests.

The DC 5010 is an IEEE 488 (GPIB) Digital Interface programmable counter that allows any manually selectable function or mode to be operated over the GPIB bus, including all input conditioning controls.

The IEEE standard identifies the interface functions of an instrument on the GPIB in terms of interface function subsets. The subsets are defined in the standard. The subsets that apply to the DC 5010 are listed in Table 1-5 at the end of this section.

The DC 5010 has a DVM mode that reads out the channel A and channel B trigger level voltages. Shaped outputs and an arming input are available at the front panel. Also available at the front panel is a signal for use with the probe compensation function.

The operating modes and front-panel settings of the DC 5010 can be set and read by programming mnemonics set to it in ASCII code over the bus. The DC 5010 connects to the bus when installed in a GPIB-compatible TM 5000-Series power module.

The DC 5010 can be equipped with an optional, oven-controlled, 10 MHz crystal oscillator to obtain an even more stable and precise internal time base.

Instrument Options

Option 01 replaces the internal 10 MHz time base (clock) circuit with a self-contained proportional temperature controlled oven oscillator for increased accuracy and stability.

Standard Accessories

- 1 Instruction Manual
- 1 Reference Guide
- 1 Cable Assembly, bnc-to-slide on connector

NOTE

Refer to the tabbed Accessories page at the rear of this manual for more information.

Performance Conditions

The limits stated in the Performance Requirements columns of the following tables are valid only if the DC 5010 has been calibrated at an ambient temperature between +20°C and +30°C and is operating at an ambient temperature between 0°C and +50°C, unless otherwise stated.

Information given in the Supplemental Information and Description columns of the following tables is provided for user information only and should not be interpreted as Performance Check requirements.

The DC 5010 must be operated or stored in an environment whose limits are described under Environmental Characteristics.

Allow at least 30 minutes warm-up time for operation to specified accuracy, 60 minutes after storage in a high-humidity environment.

Safety Certification

This instrument is listed with Underwriters Laboratories Inc. under UL Standard 1244 (Electrical and Electronic Measuring and Testing Equipment).

Table 1-1
ELECTRICAL CHARACTERISTICS

Characteristics		Performance Requirements		Supplemental Information
CHANNEL A and CHANNEL B INPUTS (also see Rise/Fall MEASUREMENT MODE INPUT SPECIFICATION)				
Input Frequency Range				
Coupling		50 Ω	1 MΩ	
DC		>0 to ≥350 MHz	>0 to ≥300 MHz	
AC		100 kHz to ≥350 MHz	16 Hz to ≥300 MHz	
Input Sensitivity				1 MΩ performance is from a 25 Ω source impedance.
Sinewave		50 Ω (Term low)	1 MΩ (Term high)	
Coupling	Attenuation			Typical sensitivity is 50 mV p-p ± 20 mV.
DC	X1	≤25 mV rms*	≤25 mV rms to 200 MHz ≤42 mV rms from 200 MHz to 300 MHz	
		≤70 mV p-p pulse*	≤70 mV p-p pulse (<200 MHz)	
	X5	≤125 mV rms*	≤125 mV rms to 200 MHz ≤210 mV rms from 200 MHz to 300 MHz	
		≤350 mV p-p pulse*	≤350 mV p-p pulse	
AC	X1	≤25 mV rms*	≤25 mV rms to 200 MHz 42 mV rms to 300 MHz	
		+ 3 dB at ≤100 kHz ≤70 mV p-p pulse	+ 3 dB at ≤16 Hz ≤70 mV p-p pulse (<200 MHz)	
	X5	≤125 mV rms*	≤125 mV rms to 200 MHz 210 mV rms to 300 MHz	
		+ 3 dB at ≤100 kHz ≤350 mV p-p pulse	+ 3 dB at ≤16 Hz ≤350 mV p-p pulse (<200 MHz)	
Dynamic Range				
Attenuation				
X1				70 mV p-p to 4 V p-p
X5				350 mV p-p to 20 V p-p
Trigger Level Range				
Attenuator				
X1		≥ +2 V to ≤ −2 V		In approximately 4 mV steps.
X5		≥ +10 V to ≤ −10 V		In approximately 20 mV steps.
Trigger Level Accuracy		±2% of reading for a dc input voltage ± 40 mVx atten.		Trigger level is calibrated in ± slope and is firmware compensated in — slope.

*0°C to 40°C; sensitivity decreases by 31% for 40°C to 50°C.

Table 1-1 (cont)

Characteristics		Performance Requirements	Supplemental Information
Auto Trigger Range (A or B)		<p>20 Hz to ≥ 350 MHz</p> <p>Minimum signal required for Auto Trigger is 100 mV p-p.</p> <p>In Ratio mode, with Channel B frequency ≥ 200 MHz, the Auto Trigger will provide a CHA B level within ± 24 mV of the 50% point.</p>	Trigger point is set (once) to a nominal 50% of the p-p input signal. For signals dc to 20 Hz (inclusive), level will still be set between 0% and 100%, but not necessarily near 50%. A ten-bit DAC is used, giving nominal 4 mV steps (X attenuation factor).
Operating Range Attenuation X1 X5 AC Coupling		<p>+2 V to -2 V (dc + peak ac)</p> <p>+10 V to -10 V (dc + peak ac)</p> <p>50 Ω input dc $\leq \pm 2$ V (dc plus peak ac) times attenuator 1 MΩ input ≤ 42 V dc + peak ac</p>	
Maximum Allowable Input (Damage Level) 50 Ω			In 50 Ω input mode, 50 Ω over-voltage protection trips in 1 M input impedance for signals greater than approximately ± 2 V times attenuator dc + peak ac to 200 kHz.
Attenuation	Impedance	Vpk ≤ 2 V	<p>dc to 350 MHz</p> <p>± 42 V dc + peak ac, dc to 200 kHz</p> <p>± 2 V dc + peak ac, 2 MHz to 300 MHz</p>
	50 Ω		
X1	1 M Ω	Vpk ≤ 10 V	<p>± 10 V dc + peak ac, dc to 350 MHz</p> <p>± 42 V dc + peak ac, dc to 1 MHz</p> <p>± 10 V dc + peak ac, 1 MHz to 300 MHz</p>
	50 Ω		
X5			
Input Impedance	50 Ω	50 Ω approximately $\pm 3\%$ dc	VSWR approximately 1.5:1, dc to 350 MHz
	50 Ω ac		Bleeder resistor results in ≈ 390 k Ω dc input resistance.
	1 M Ω	1 M Ω approximately $\pm 1\%$ 23 pF approximately $\pm 10\%$ (2.2 pF)	<p>For inputs greater than ± 5 Vdc + peak ac, input impedance becomes approximately 300 kΩ 1000 pF, X1.</p> <p>Input C from X1 to X5 are equal by approximately $\pm 1\%$.</p>

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Bandwidth Limit		Above 20 MHz minimum signal increases 40 dB/decade to ≈ 1 V p-p. Above approximately 80 MHz no amount of input signal can cause triggering.
Channel Isolation, Crosstalk	50 Ω , Pos Slope, DC Coupling, X1	No effect when both signals are below 100 MHz and ≤ 2 Vpk-pk. For ≤ 1 Vpk-pk signals between 100 MHz and 350 MHz (CH A) or 300 MHz (CH B). There is no effect if the slower signal has a square edge or a slew rate ≥ 80 V/ μ sec.

RISE/FALL MEASUREMENT MODE INPUT SPECIFICATION

Range			In this mode, the input amplifiers are commoned to the CH A bnc. CH B bnc is an open circuit.
Coupling	50 Ω	1 MΩ	
DC	4.0 nsec to 2.5 × 10 ⁴ sec	5 nsec to 2.5 × 10 ⁴ sec	
AC	4.0 nsec to 18 μsec	5 nsec to 22 msec	AC measurements near the slower limit are not recommended, because they become duty cycle dependent.
Frequency	50 Ω	1 MΩ	Upper frequency limit is essentially a limit on the repetition rate at which rise/fall edges may occur.
DC	20 Hz to >80 MHz	20 Hz to >80 MHz	
AC	100 kHz to >80 MHz	16 Hz to >80 MHz	
			Lower limit is a limit on the ability to acquire peak voltage levels. Once levels are set, rise/fall will work down to ≤0 Hz.
Input Sensitivity	50 Ω	1 MΩ	1 MΩ response is from 25 Ω source impedance.
Coupling			Both channel modes set the same.
Attenuation			
DC	X1	50 mV rms 140 mV p-p pulse	
	X5	250 mV rms 700 mV p-p pulse	50 Ω input impedance is maintained via an internal power-splitter causing X2 attenuation.
AC	X1	50 mV rms +3 dB at 20 kHz 140 mV p-p pulse	These specifications apply only when both channels have the same setup.
	X5	250 mV rms +3 dB at 20 kHz 700 mV p-p pulse	

Table 1-1 (cont)

Characteristics		Performance Requirements		Supplemental Information
Dynamic Range		50 Ω	1 MΩ	Maxima are centered at zero volts. Minimum measurable rise/fall signal amplitude is ten times greater than minimum dynamic range.
Attenuation	X1	140 mV p-p to 8 V p-p	70 mV p-p to 4 V p-p	
	X5	700 mV p-p to 10 V p-p	350 mV p-p to 20 V p-p	
Trigger Level Range		50 Ω	1 MΩ	50 Ω, ×5, only ±5 V of the trigger level range is usable because only ±5 V is allowed as an input. When using 50 Ω input mode, the displayed trigger level is 1/2 true trigger level due to 50 Ω power splitter divider action.
Attenuation	X1	+4 V to -4 V ≈8 mV steps	+2 V to -2 V ≈4 mV steps	
	X5	(+5 V to -5 V) +20 V to -20 V ≈40 mV steps	+10 V to -10 V ≈20 mV steps	
Operating Range		50 Ω	1 MΩ	For 10% and 90% trigger point. For inputs less than minimum, 10% and 90% points are not achievable due to sensitivity. Minimum signal is 10 times minimum dynamic range.
Attenuation	X1	1.4 V p-p minimum, +4 V to -4 V dc + peak ac max	700 mV p-p minimum, +2 V to -2 V dc + peak ac max	
	X5	7.0 V p-p minimum, +5 V to -5 V dc + peak ac max	3.5 V p-p minimum, +10 V to -10 V dc + peak ac max	
Maximum Allowable Input (Damage Level)				
Attenuation	Impedance	X1	50 Ω	±4 V dc + peak ac, dc to 80 MHz
			1 MΩ	See CHANNEL A and CHANNEL B inputs
		X5	50 Ω	±5 V dc + peak ac, dc to 80 MHz ^a
			1 mΩ	See CHANNEL A and CHANNEL B inputs
Input Impedance Channel A				Channel B is an open circuit.
		1 MΩ	500 kΩ, ±2% 47 pF, ±10%	X5 probe becomes X9 X10 probe becomes X19
		50 Ω	50 Ω, ±3%	
GENERAL				
Probe Compensation Output Jack				5 V p-p nominal. 110 Hz nominal. 1 ms width nominal.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Arming Input Required Signal Input Pulse Response	low ≤ 0.4 volts high ≥ 2.4 volts (TTL) Pulse width ≥ 100 ns	Maximum voltage $V_{pk} < 10$ volts.
Shaped Output		≥ 100 mV typically to 350 MHz into 50Ω load. Delay from front-panel input to shaped output. CH A 7.2 nsec typically CH B 7.0 nsec typically CH B commoned from CH A 7.6 nsec typically.
External Clock Input	≥ 500 mV rms into $1 k\Omega$ (ac coupled) 1, 5, or 10 MHz	
10 MHz Clock Output	low ≤ 0.4 V high ≥ 2.4 V (TTL) (pins 15B and 15A (gnd))	Drives 1 TTL load.
Phase Modulated Clock (time interval functions)		≥ 3 ns p-p jitter induced onto 1 MHz reference. (Test point on rear of Auxiliary board.)

STANDARD INTERNAL TIME BASE

Frequency at calibration	$10 \text{ MHz} \pm 1 \times 10^{-7}$	10 MHz
Error Terms		
Temperature Stability (0°C to $+50^\circ\text{C}$)	$\pm 5 \times 10^{-6}$	
Aging	$\leq 1 \times 10^{-6}/\text{year}$	
Adjustment Resolution	$\pm 5 \times 10^{-8}$	

OPTIONAL INTERNAL TIME BASE

Frequency at calibration	$10 \text{ MHz} \pm 2 \times 10^{-8}$	With proportional oven
Error terms:		
Temperature Stability (0°C to $+50^\circ\text{C}$)	$\pm 2 \times 10^{-7}$ after warmup	
Warm-up Time	Within $\pm 2 \times 10^{-7}$ of final frequency in less than 10 minutes when cold started at 25°C ambient.	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Aging		
At time of shipping	1×10^{-8} /day maximum.	
After 30 days of continuous operation	4×10^{-8} /week maximum	
After 60 days of continuous operation.	$<1 \times 10^{-6}$ /year maximum	
Short Term Stability		$\leq 1 \times 10^{-9}$ rms based on 60 consecutive 1 second measurements.
Adjustment Resolution	$\pm 2 \times 10^{-8}$	
Adjustment Range		Sufficient for 8 years of aging.

FUNCTIONS

Frequency A Range	$\leq 36 \mu\text{Hz}$ to $\geq 350 \text{ MHz}$	
Resolution		$\pm \text{LSD} \pm 1.4 \times \frac{\text{A Trig Jitter Error}}{N}$ $\times (\text{Freq. A})^2$
Accuracy		Resolution $\pm (\text{Timebase Error} \times \text{Freq. A})$
Period A Range	3.125 ns to 7.6 hours	
Repetition Rate	$\geq 350 \text{ MHz}$	
Clock Period Counted		3.125 ns
Resolution		$\pm \text{LSD}^b \pm \frac{1.4 \times \text{A Trig Jitter Error}}{N}$
Accuracy		Resolution $\pm (\text{Timebase Error}) \times \text{Period A}$
Ratio B/A Range	10^{-8} to 10^9 with correct decimal point displayed. (10^{-11} to 10^{12} without decimal point.)	Averaged by A
Frequency Range (A & B)	$\leq 36 \mu\text{Hz}$ to $\geq 350 \text{ MHz}$	
Resolution		$\pm \text{LSD} \pm \frac{1.4 \times \text{B Trig Jitter Error} \times \text{Freq. B}}{N}$
Accuracy		Same as Resolution

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Time A → B Range	2.0 nsec ^c to 7.6 hours	
Resolution		$\pm \text{LSD} + \frac{1}{\sqrt{N}}$ (\pm A Trigger Jitter Error \pm B Trigger Jitter Error)
Accuracy		Resolution \pm (Timebase Error \times Time Interval) \pm Channel Delay Mismatch ^d + B Trigger slew error-A Trigger slew error
Clock Period counted		3.125 nsec
Minimum Time A → B	$0.0 \pm 2.0 \text{ nsec}^c$	
Minimum Time B → A	$\leq 12.5 \text{ nsec}$	($\geq 70 \text{ MHz Rep. Rate}$)
Channel Delay Mismatch Internal	$\leq 2 \text{ nsec}$ nominal, without null	
Front Panel (Shaped Out)		$\leq 500 \text{ ps}$
Events B Dur A		Averaged by A
Range	10^{-8} to 10^9	
Maximum B Frequency	$\geq 350 \text{ MHz}$	
Maximum A Frequency	$\geq 80 \text{ MHz}$	
Minimum A Pulse Width	$\leq 4.0 \text{ nsec}$	
Minimum \bar{A} Pulse Width	$\leq 8.5 \text{ nsec}$	
Resolution		$+\text{LSD} + \frac{\text{Freq B}}{\sqrt{N}}$ (\pm A Start Trigger Jitter error \pm A Stop Trigger Jitter Error)
Accuracy		Resolution + Freq B (Stop Slew Rate Error – Start Slew Rate Error) + Freq B \times (5 $\pm 2 \text{ nsec}$)
Width A Range	$\leq 4 \text{ nsec}$ to 7.6 hours	Taken at 50% trigger point.
Repetition Rate	$\geq 50 \text{ MHz}$	
Resolution		$\pm \text{LSD} + \frac{1}{\sqrt{N}}$ (\pm Start edge Trigger Jitter Error \pm Stop Edge Trigger Jitter Error)
Accuracy		Resolution \pm Timebase Error \times Width A + (Stop Slew Rate Error – Start Slew Rate Error) $\pm 2 \text{ nsec}$
Clock period counted		3.125 nsec
Minimum Time Stop Edge to Start Edge	$\leq 1.6 \text{ nsec}$	

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
Totalize A Range	0 to 10^9 counts	(to 8.7×10^{12} with no decimal point.)
Repetition Rate	0 to ≥ 350 MHz	See CHANNEL A and CHANNEL B INPUTS for pulse specifications.
Totalize ^e A+B Range	0 to 10^9 ($A + B \leq 10^9$)	(to 8.7×10^{12} with no decimal point.)
Repetition Rate (A or B)	0 to ≥ 350 MHz	See CHANNEL A and CHANNEL B INPUTS for pulse specifications.
Totalize ^e A-B Range	-10^8 to 10^9	<p>(-8.7×10^{12} to 8.7×10^{12} with no decimal point or minus indication.)</p> <p>Note: either $A \geq 10^{12}$ or $B \geq 10^{12}$ will lead to overflow, independent of the value of (A-B). See CHANNEL A and CHANNEL B INPUTS for pulse specifications.</p>
Repetition Rate (A or B)	≥ 350 MHz	
Rise/Fall A Range	4.0 ns \rightarrow 10^4 sec (dc coupling) 50 Ω 5.0 ns \rightarrow 10^4 sec (dc coupling) "1 M Ω ".	Risetime of "1 M Ω " is ≈ 4.5 ns
Repetition Rate	Minimum time between rising (falling) edges is 14.5 ns (70 MHz)	
Trigger Points	Trigger levels are automatically set to the 90% and 10% points of the incoming signal, to a resolution that depends on the incoming signal amplitude.	In this mode Channels A and B are commoned. This changes the input characteristics. See RISE/FALL MEASUREMENT MODE INPUT SPECIFICATION.
Resolution		$\pm \text{LSD} + \frac{1}{\sqrt{N}}$ (\pm Start Trig Jitter Error \pm Stop Trigger Jitter Error)
Accuracy		Resolution \pm (Timebase Error \times TI) ± 2 nsec ± 4 mV \times slew rate A (near 10%) ± 4 mV \times slew rate A (near 90%)
Time Manual Range	3.125 ns to 3.125×10^4 sec (≈ 8 hours)	
Resolution		3.125 nsec clock is counted, but usable resolution is $\approx \pm 10$ ms due to START/STOP buttons
Probe Comp Accuracy		<p>$\times 5$ probe, 1.5% nominal.</p> <p>$\times 10$ probe, 3% nominal.</p> <p>$\times 100$ probe, 30% nominal.</p>

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
-----------------	--------------------------	--------------------------

Resolution and Accuracy

Definitions

$$\text{Trigger Jitter Error (seconds rms)} = \frac{\sqrt{({}^e n_1)^2 + ({}^e n_2)^2} \text{ Volts rms}}{|\text{Input slew rate at trigger point}| \text{ (volts/sec)}}$$

where $({}^e n_1) = 140 \mu\text{V rms}$ typical counter input noise for $1 \text{ M}\Omega$ filter on; $240 \mu\text{V rms}$ typical for $1 \text{ M}\Omega$ filter off; $340 \mu\text{V rms}$ typical for 50Ω .


$({}^e n_2) = V$ rms noise voltage of users input signal at trigger point, measured with the appropriate bandwidth.


Note: Best usable resolution is ± 1 psec in Time Interval (TI) modes.

$$\text{Slew Rate Error (seconds)} = \frac{*\text{trigger level error (Volts)}}{|\text{Input slew rate at trigger point}| \text{ (volts/sec)}}$$

*Trigger level error =

All functions except WIDTH A and EVENTS B	pos slope	trigger accuracy times attenuation factor
DUR A	neg slope	(trigger accuracy ± 10 mV) times attenuation factor

WIDTH A, 	start edge	trigger accuracy times attenuation factor (trigger accuracy + hyst) times attenuation factor
	stop edge	


	start edge	(trigger accuracy + hyst) times attenuation factor
	stop edge	trigger accuracy times attenuation factor

EVENTS B	Same as WIDTH A, except each number is multiplied by Freq B
DUR A	

Note: Trigger Accuracy, (see CHANNEL A and CHANNEL B INPUTS)
Input hysteresis is typically 50 mV p-p times attenuation, maximum 70 mV p-p times attenuation.

Internal slew rate = 800 ps (50Ω)
1.3 nsec ($1 \text{ M}\Omega$)
18 nsec (20 MHz filter)

N = Number of Averages

The minimum number of averages is selected by the AVERAGES button and the  buttons in decade steps from 1 to 10^9 . At Channel A repetition rates above approximately 250 Hz the actual number of averages will be:

$$N \approx [\text{FREQ A (Hz)} \times 4 \text{ msec}] + \text{AVGS}$$

$$N = \text{AVGS setting (below 250 Hz)}$$

This typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. Arming must be used when measuring only one event out of a pulse train (multiple events) with signals ≥ 250 Hz.

Table 1-1 (cont)

Characteristics	Performance Requirements	Supplemental Information
In the AUTO mode the counter measures with a fixed measurement time of about 300 msec (or the time for one event, whichever is greater).		
$N \leq \text{Freq A (Hz)} \times .3 \text{ seconds (N always } \geq 1)$		
LSD:		
FREQ	$\frac{(\text{Freq A})^2}{N \times 3.2 \times 10^8}$	
PER	$3.125 \text{ nsec for } N \leq 10, \frac{10 \text{ nsec}}{N} \text{ for } N > 10$	
RATIO	$\frac{\text{Freq A}}{\text{Freq B} \times N}$	
TIME A→B & RISE/FALL A	$3.125 \text{ nsec for } N \leq 10, \frac{10 \text{ nsec}}{\sqrt{N}} \text{ for } N > 10$	
WIDTH A	$3.125 \text{ nsec for } N \leq 10, \frac{10 \text{ nsec}}{\sqrt{N}} \text{ for } N > 10$	
EVENTS B DUR A	$\frac{\text{Period B}}{\text{Width A} \times N} \times \text{Events B dur A}$	

Time Base Error: The sum of all the errors specified for the time base used.

^aOver voltage protection still functions, but in rise/fall, (50 Ω and $\times 5$) it may not always protect the 25 Ω series input resistor.

^bWith 10⁹ Averages selected, LSD can be as small as 31.25 attosec.

^cCan be set to 0.0 ns by use of "NULL" function.

^dCan be removed by use of "NULL".

^eThe B channel will not count events until after the first valid A channel count.

**Table 1-2
MISCELLANEOUS**

Characteristics	Description	
Power Requirements	TM 500 series power module	TM5000 series power module
DC 5010	Not	14.5 W
DC 5010 Opt 01	Allowed	19.3 W
Recommended Calibration Interval	2000 hours or 6 months whichever occurs first	
Minimum Display Time	100 msec (typical)	
Auto Averages Measurement Time	300 msec (typical)	
GPIB Data Output Rate	≈10 readings/sec max	

**Table 1-3
ENVIRONMENTAL^a**

Characteristics	Description	
Temperature	Meets MIL-T-28800B, class 5.	
Operating	0°C to +50°C	
Non-operating	–55°C to +75°C	
Humidity	95% RH, 0°C to 30°C 75% RH to 40°C 45% RH to 50°C	Exceeds MIL-T-28800B, class 5.
Altitude	Exceeds MIL-T-28800B, class 5.	
Operating	4.6 km (15,000 ft)	
Non-operating	15 km (50,000 ft)	
Vibration	0.38 mm (0.015") peak to peak, 5 Hz to 55 Hz, 75 minutes.	Exceeds MIL-T-28800B, class 5 when installed in qualified power modules. ^b
Shock	30 g's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800B, class 5 when installed in qualified power modules. ^b
Bench Handling ^c	12 drops from 45°, 4" or equilibrium, whichever occurs first.	Meets MIL-T-28800B, class 5.
Transportation ^c	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.	
EMC	Within limits of MIL-461A, with exceptions ^d , and F.C.C. Regulations, Part 15, Subpart J, Class A. Unused plug-in compartments must be filled with blank plug-ins.	
Electrical Discharge	20 kV maximum charge applied to instrument case.	

^aWith power module.^bRefer to TM 5000-Series power module specifications.^cWithout power module.^dWithin 4 dB of REO2 at 130 MHz and 960 MHz. Within 20 dB of REO2 at 320 MHz.

Table 1-4
PHYSICAL CHARACTERISTICS

Characteristics	Description
Finish	Anodized aluminum chassis.
Net Weight (nominal) DC 5010 Option 01	3 lb. 7 oz. 3 lb. 11 oz.
Nominal Overall Dimensions Height Width Length	126.0 mm (4.96 inches) 134.5 mm (5.29 inches) 278.8 mm (10.98 inches)
Enclosure Type and Style per MIL-T-28800B Type Style	III E (Style F in rackmount power module)

Table 1-5
IEEE 488 (GPIB) INTERFACE FUNCTION SUBSETS

Function	Subset	Capability
Source Handshake	SH1	Complete.
Acceptor Handshake	AH1	Complete.
Basic Talker	T6	Responds to Serial Poll.
Basic Listener	L4	Unlisten if My Talk Address (MTA) is received.
Service Request	SR1	Complete.
Remote-Local	RL1	Complete
Parallel Poll	PP0	Does not respond to Parallel Poll.
Device Clear	DC1	Complete
Device Trigger	DT1	Complete
Controller	C0	No controller function.

OPERATING INSTRUCTIONS

INTRODUCTION

First Time Inspection

Inspect the instrument for visible damage (dents, scratches, etc.). Keep the original shipping container and packing material for future use. If the instrument is damaged, notify the carrier and the nearest Tektronix Service Center or representative.

Repackaging for Shipment

Should it become necessary to return the instrument to a Tektronix Service Center for service or repair, attach a tag to the instrument showing the owner (with address) and the name of the individual to be contacted, complete instrument serial number, option number, and a description of the service required.

If the original container and packaging material is unfit for use or not available, repackage the instrument as follows:

1. Obtain a carton of corrugated cardboard having inside dimensions no less than six inches more than the instrument dimensions; this will allow for cushioning. The shipping carton test strength for your instrument is 200 pounds.
2. Surround the instrument with polyethylene sheeting to protect the finish.
3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between carton and instrument, allowing at least three inches on all sides.
4. Seal the carton with shipping tape or industrial staples.
5. Mark the shipping carton "FRAGILE INSTRUMENT" to indicate special handling.

Operating and Non-Operating Environments

The instrument may be operated, stored, or shipped within the environmental limits stated in the Specification section of this manual. However, the counter should be protected at all times from temperature extremes which can cause condensation to occur within the instrument.

PREPARATION FOR USE

Rear Interface Considerations

A slot between pins 21 and 22 on the rear connector identifies this instrument as a member of the TM 5000 counter family. If you desire to use your counter to build a system, insert a family barrier key (Tektronix Part No. 214-1593-02) in the corresponding position of the selected power module jack in order to prevent plug-ins belonging to a different family from being used in that compartment of the power module.

WARNING

To avoid electric shock, disconnect the power module power cord before inserting the family barrier key in the power module jack. Refer the barrier key insertion to qualified service personnel.

The DC 5010 has the following rear interface input and output features:

- Arming Input
- 10 MHz Clock Output
- External Clock Input (1, 5, 10 MHz)
- Prescaler Function
- Reset Input

NOTE

Rear interface information will be found in the Maintenance section of this manual. Refer the interface connections to qualified service personnel.

Installation and Removal

The DC 5010 can only be used in the TM 5000-Series power modules.

NOTE

Refer to the Operator's Safety Summary in the front of this manual before installing this instrument in the power module.

Refer to the power module instruction manual and make sure that the line jumpers are positioned correctly for the line voltage in use. Check the counter and the power module for the proper fuses. Be certain that the power plug for the power module has the proper grounding conductor.

CAUTION

To prevent damage to the instrument, turn the power module off before installation or removal from the power module. Do not use excessive force to install or remove the instrument from the power module.

Check to see that the plastic barrier keys on the interconnecting jack of the selected power module compartment match the cutouts in the rear interface connector for the counter. If they do not match, do not insert the counter until the reason is investigated.

If the cutouts and barrier keys match, align the chassis of the counter with the upper and lower guides of the selected compartment. See Fig. 2-1. Insert the counter into the compartment and press firmly to seat the rear interface connector. Apply power by operating the POWER switch on the power module.

The plastic lockouts (see Fig. 2-1) prevent programmable instruments from being used in the TM 500-Series (manual instruments) Power Module.

To remove the counter from the power module, turn off the POWER switch, pull the release latch knob (located in the lower left front corner) until the interconnecting jack disengages. Pull the counter straight out of the power module compartment.

FRONT PANEL OPERATION

The following information is a brief, functional description of the front panel display, controls, and connectors (See Fig. 2-2).

FRONT PANEL DISPLAY

① Display

The display contains nine seven-segments LEDs and eight annunciators. All measurement results are displayed with the best possible resolution. The readout (result) for the

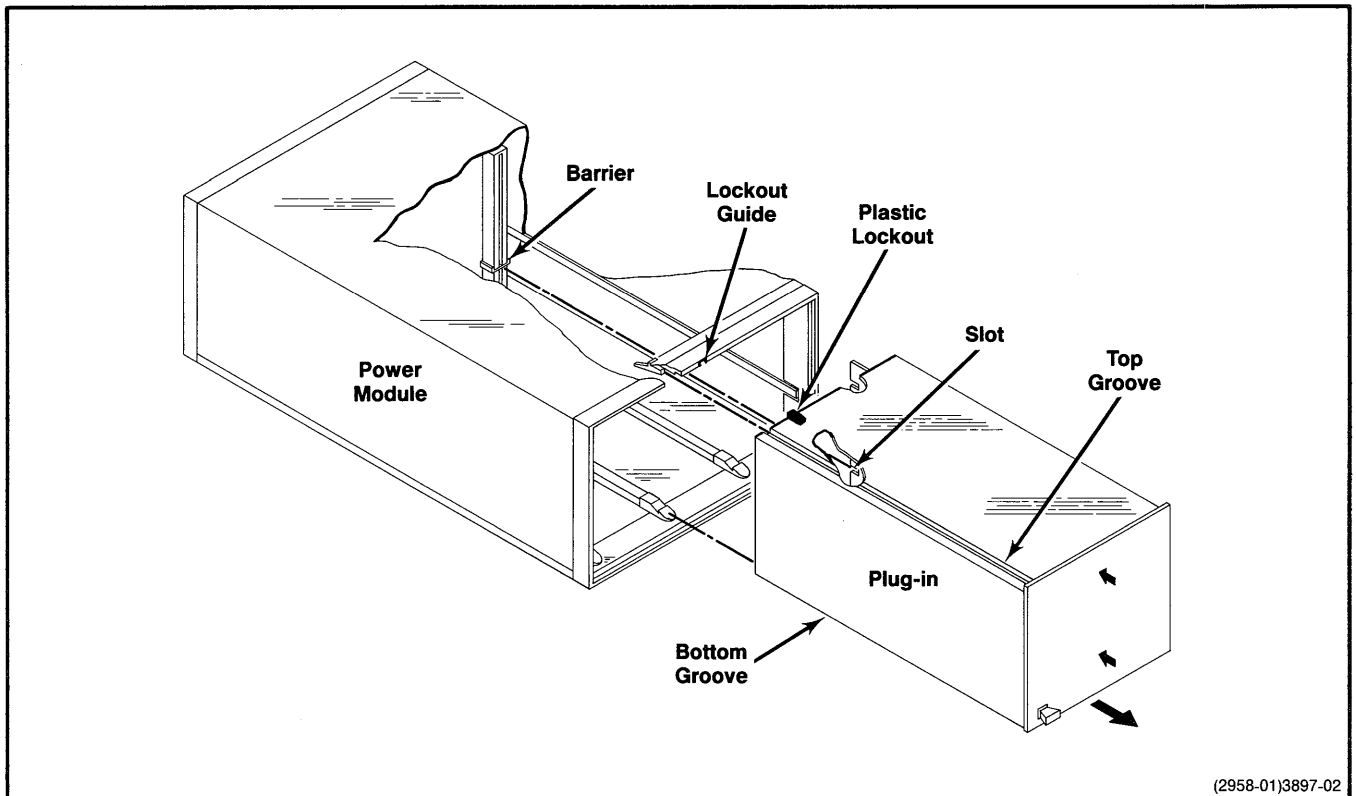


Fig. 2-1. Plug-in installation and removal.

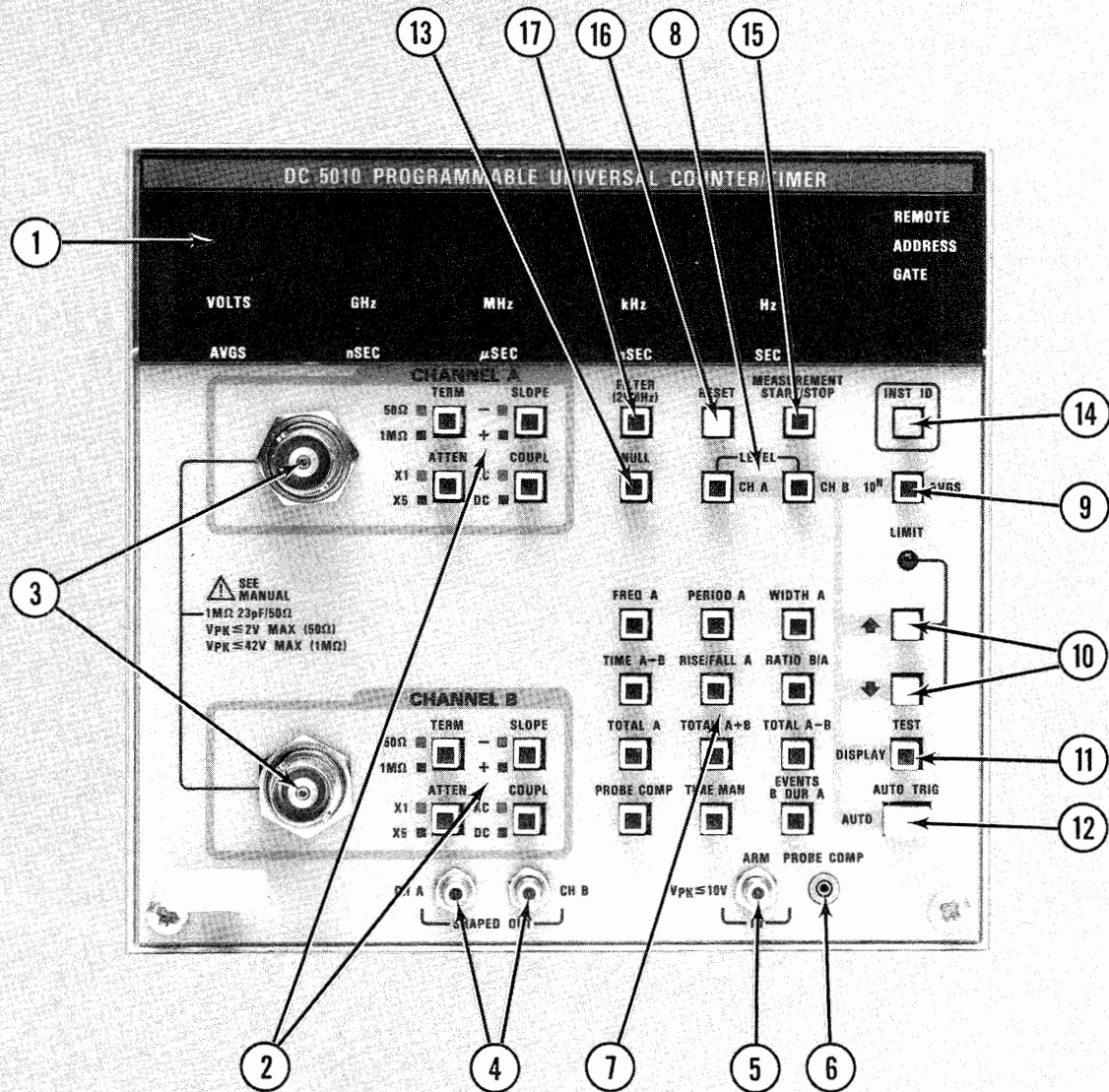


Fig. 2-2. DC 5010 front panel display, controls and connectors.

measurement is always displayed in a right-hand justified format with the decimal point automatically positioned. Displayed count overflow is indicated by a flashing display. In measurements such as Time A→B, where the number of resolved digits increases more slowly with an increase in averaging, only correct (resolvable) digits are displayed.

Five of the annunciators are used to indicate the units of measurements: Hz/SEC for Hertz or seconds, kHz/mSEC for kilohertz or milliseconds, MHz/ μ SEC for megahertz or microseconds, GHz/nSEC for gigahertz or nanoseconds, and VOLTS/AVGS for (trigger level) Volts, and (the exponent of) the number of Averages.

The GATE annunciator, when illuminated, indicates that the counter is in the process of accumulating counts for the measurement.

The REMOTE annunciator indicates the instrument is in a remotely-programmed state, when illuminated. The ADDRESS light indicates that the instrument is actually being addressed over the GPIB bus.

In addition to displaying the measurement results, the counter uses the extreme left three digits of the seven-segment LED display to indicate internal or operating error codes. The two digits (extreme left-digit Channel A and the extreme right-digit Channel B) on the display report the results of compensating external signal probes. See Self Test Display and Probe Compensation.

In addition, many of the front-panel pushbuttons are illuminated.

FRONT PANEL CONTROLS

② TERM, SLOPE, ATTEN, and COMPL (CHANNEL A and CHANNEL B)

TERM—50 Ω , 1 M Ω (termination). When unlighted, selects 1 M Ω , 23 pF; when lighted, selects 50 Ω . Allows user to properly terminate 50 Ω inputs when required. (Unit will automatically revert to 1 M Ω , 23 pF in the event of an overload.)

ATTEN—X1, X5. When unlighted, selects X5; when lighted, selects X1. Allows the signal to be applied directly to the amplifier without attenuation or attenuated by a factor of five. The attenuator effectively increases the input hysteresis and trigger level range by a factor of five.

SLOPE —, +. When unlighted, selects +; when lighted, selects —. This button selects the slope of the signal at the trigger level crossing, which is recognized as a countable event. CHANNEL A slope also selects between risetime (+ Slope) and fall time (— Slope); it must be set before the RISE/FALL A button is pushed.

COUPL—AC, DC. When unlighted selects DC; when lighted selects AC. DC is direct coupled. AC inserts a capacitor in series with the input which allows small signals with large dc offsets to be measured.

FRONT PANEL CONNECTORS

③ CHANNEL A - CHANNEL B (Identical in performance)

1 M Ω 23 pF/50 Ω . Signal input connectors.
Vpk \pm 2 V max (50 Ω)
Vpk \pm 42 V max (1 M Ω)

④ CH A, SHAPED OUT - CH B, SHAPED OUT (Shaped Out A/B/COM)

These outputs provide an exact replica of the internal signal that is being measured. It is an aid to proper triggering on complex waveforms. The outputs provide a 100 mV signal near ground from 50 Ω (200 mV unterminated). These are full bandwidth outputs, and function well beyond 350 MHz.

⑤ ARM, IN - Vpk \leq 10 V (Arming TTL)

This input (normally high) allows the counter to measure only when in the high state. When in the low state, this input prevents the counter from measuring. (Alternatively, this input may be provided through the rear interface.)

⑥ PROBE COMP

This test point provides a rectangular waveform (\approx 5 volts) that can be used in conjunction with the "PROBE COMP" function to compensate test probes (see Probe Compensation in this section.)

FRONT PANEL PUSH BUTTONS

⑦ Function Pushbuttons

FREQ A (Frequency A). Measures the period of the Channel A signal, calculates and then displays frequency.

PERIOD A. Measures and displays the period of the Channel A signal.

WIDTH A. Measures the width of a pulse on Channel A. When CHANNEL A SLOPE is +, the positive pulse width is measured. When CHANNEL A SLOPE is negative, the negative pulse width is measured.

TIME A + B. Measures the time between the first occurrence of an event on Channel A and the first succeeding event on Channel B.

RISE/FALL A (Risetime A - Falltime A). Automatically measures the risetime/falltime (10% and 90%) of the signal appearing on CHANNEL A. The appropriate trigger levels are measured and calculated at the time the button is pressed. If the signal amplitude changes, the button may be pressed again. When CHANNEL A SLOPE is +, risetime is measured; for falltime, press CHANNEL A SLOPE = (–) before pressing RISE/FALL A. Since this measurement uses the B channel, its settings are automatically updated to match those of CHANNEL A. After pressing RISE/FALL A, the user is free to modify either CHANNEL A or CHANNEL B separately to suit special measurement needs, though the result may no longer be a traditional Rise/Fall time. (See Risetime A and Falltime A later in this section).

RATIO B/A. Measures and displays the ratio of events occurring on Channel B divided by the events occurring on Channel A over the same time interval.

The three totalize modes of operation count the events that are the occurrences of pulses on Channel A and B.

TOTAL A (Totalized A). In Total A, only Channel A events are displayed.

TOTAL A+B. Displays the total number of events on Channel A plus the total number of events on Channel B. Channel B events are counted only after the first valid Channel A event.

TOTAL A–B. Displays the total number of events on Channel A minus the total number of events on Channel B. Channel B events are counted only after the first valid Channel A event. If A-B is negative, a minus sign is lighted.

NOTE

After a TOTALIZE button is pushed, the START/STOP button lights to indicate a "STOPped"

condition. It must then be pressed to start the Totalize process.

Also, the number of digits displayed is "scaled" by the AVGS setting. This scaling does not affect the actual count process, and therefore may be changed while counting without losing counts. Even when counting has been stopped, the display may be moved to the right or left.

PROBE COMP. When in this mode, a visual indication is given (in the display area) that allows the user to easily compensate attached high impedance probes. (See Probe Compensation in this section.)

TIME MAN (Time Manual). Measures time after pressing the MEASUREMENT START/STOP pushbutton (once to start and once to stop). The accumulated count (time) is not reset until the RESET pushbutton is depressed. Like the Totalize modes, this function defaults to the STOPped state when first selected, as indicated by the START/STOP button being illuminated.

EVENTS B DUR A (Events B During A). Measures the number of occurrences of pulses on Channel B during the time interval where the Channel A input signal is greater than (+ SLOPE) or less than (– SLOPE) the Channel A trigger level.

8 LEVEL CH A, CH B

Displays the chosen trigger level. Trigger level settings may be set for either channel by depressing the appropriate LEVEL button and then using the increment or decrement buttons (labeled 10). To exit this mode, the user can press the LEVEL A (B) button a second time or press any function button.

9 AVGS (Averages)

Pressing this button displays the current AVGS setting and readies the instrument for a new setting. The user can then choose between several modes.

AUTO - (push the AUTO button, a –1 will be displayed). This mode provides the best resolution possible with a measurement time of approximately 300 mS.

0 - (decrement exponent to zero). The selected measurement is made with at least one event. This is the mode to be used for single-shot measurements. At most frequencies, more than one event will actually be averaged; see the Specification section for further detail.

10ⁿ, n=1 to 9 - Provides selection of minimum number of averages in decade steps.

- ↕ The increment/decrement keys are used to increase or decrease the exponent to the next legal setting.

NOTE

The AVGS settings affects the number of digits displayed for Totalize measurements. When in Auto on n=0, the first nine digits to the left of the decimal point are displayed. When n=1 to 9, the measurement result is "scaled" by 10ⁿ and displayed.

10 ▲

This button increments the appropriate trigger level if LEVEL CH A -CH B is selected, or the number of averages if AVGS has been selected. Voltage levels are incremented or decremented in steps of 4 mV × attenuating setting.

▼ This button decrements the appropriate trigger level if LEVEL CH A - CH B is selected, or the number of averages if AVGS has been selected.

LIMIT

This light goes on whenever either the increment (↑) or decrement (↓) button has incremented or decremented a setting to its limit. This light goes out when increment (↑) or decrement (↓) button is released.

11 TEST/DISPLAY

When either of the LEVEL CH A, LEVEL CH B buttons or the AVGS button is lighted, this button alternates what is being displayed in the seven-segment readout. Pressing it once makes the readout revert back to displaying the functional results (frequency, period, etc.) while still leaving the increment/decrement buttons active. Pressing the button again will alternate the display back to showing the voltage level or averages exponent. This allows the user to view either the parameter being changed or the effect of that change on the functional results.

When the LEVEL buttons or the AVGS button is unlighted, the TEST/DISPLAY button is used to select the Test mode. In this mode a portion of the power up test (all but the RAM portion) is repeated. If an error is ever encountered, the test stops, with the appropriate error code displayed. To exit Test mode, push any other function key.

12 AUTO TRIG/AUTO

If the LEVEL buttons and the AVGS button are unlighted, pressing this button causes an auto trigger on both Channel A and Channel B (the maximum and minimum peak values of the Channel A and B input signals are measured and the trigger levels are set at the midpoints). If LEVEL CH A is selected, pressing this button causes an Auto trigger on Channel A only, and similarly for LEVEL B lighted. If AVGS is lighted, pressing the button enters a -1, which is the code for Auto Averages.

13 NULL

Pressing the NULL button stores the present measurement result and then subtracts that number from all subsequent measurements (while the button remains lighted). It is most useful in Time A→B measurements, where it can be used to null out systematic errors such as unequal cable lengths and channel mismatches; however, it is available in all measurement functions.

The averages setting may be changed without losing the NULL stored measurement. Now, the instrument will be subtracting two numbers of differing resolution. Since the result of such a subtraction actually has the resolution of the lesser resolution number, that is the one that the counter automatically uses to determine how many digits to display.

Pressing the button again will re-null the result.

To exit the Null mode, press any function button (including that of the function already chosen).

14 INST ID

This pushbutton, when pressed, displays the current GPIB address and message terminator selected in the DC 5010. It will send an SRQ if enabled, even when in Local Lockout, and it's therefore a useful way for an operator to signal the controller during the running of a program.

15 MEASUREMENT START/STOP

This pushbutton can be used in all of the Function modes except Probe Comp and Test. When it's lighted, measurement is in the "STOPped" state. Pressing the button causes a "STOPped", Totalize, or Time Manual measurement to "Start" from the displayed result. Other measurements (except Probcomp and Test) will "Start" a new measurement. When "Started", pressing the button causes all measurements (except Probcomp and Test) to stop counting. When "STOPped", Totalize and Time Manual measurements read the final count in the count chains and update the display one more time.

16 RESET

When a measurement has been stopped, this pushbutton, when pressed, will initiate another single measurement. If RESET is pressed while the counter is in the middle of a measurement, the current measurement will be aborted and a new measurement started. RESET, while pressed, also provides a segment test for all the front panel LEDs, including pushbuttons and annunciators.

17 FILTER (20 MHz) (CHANNEL A and CHANNEL B)

When this button is lighted, the bandwidth of both channels is reduced to 20 MHz. This allows rejection of high frequency noise. It may also be used when initially setting Auto trigger levels or Rise/Fall levels for a signal with overshoot or undershoot.

OPERATORS FAMILIARIZATION

INTRODUCTION

General Operating Characteristics

The DC 5010 is a programmable universal counter based on a microprocessor system. The counter is capable of 11 measurement functions with full nine-digit resolution, plus two specialized functions; probe compensations (PROBE COMP) and self-test (TEST).

The microprocessor system automatically sets the measurement gate interval, performs the necessary calculations on the acquired data, and causes the result to be displayed with the best possible resolution for the selected measurement FUNCTION, number of averages (AVGS), and operating conditions.

Self Test Display

When power is applied, one of the error codes listed in Table 2-1 may appear in the display window if the counter fails its self-test routine. Refer the error code condition to qualified service personnel.

NOTE

At power up, a signal with a large dc offset voltage connected to the input terminals for either channel may cause the entire input signal to be outside the triggering level range. If this condition exists, an error code may be displayed. If any of these conditions occur, disconnect all inputs and reapply power. This error condition can also be caused by a low level ARM input signal during power-up.

NOTE

Refer error code conditions to qualified service personnel.

Table 2-1

FRONT-PANEL DISPLAY ERROR CODES	
Serial I/O Fault	313
Channel A	
Counter Integrity	320-324, 329
Channel B	
Counter Integrity	330-334, 339
System RAM Error U1410	340
System RAM Error U1610	341
System RAM Error U1311	342
ROM placement error U1610	361
ROM placement error U1102	374
ROM placement error U1201	375
ROM placement error U1410	380
ROM checksum error U1610	381
ROM checksum error U1102	394
ROM checksum error U1201	395

INPUT CONSIDERATIONS

Maximum Safe Input Voltage Limits



CAUTION

To avoid instrument damage, make certain that the input voltages to the front panel connectors or rear interface inputs do not exceed their specified limits. See Specification section.

The outer shell of the front panel bnc connectors is connected to earth ground through the ground connection for the power module power cord.

Always use a step-down isolation transformer (less than 15 V output) when measuring power line frequencies (50 or 60 Hz).

Be careful with high-frequency, high-amplitude signals (above 80 MHz). The front panel maximum safe input voltage at these high frequencies is 4 V, peak-to-peak times attenuator setting.

Connecting External and Internal Signal Sources

The DC 5010 can be used to measure input signals to either channel from the front panel. The SLOPE, TERM, ATTN, and COUPL pushbuttons are effective in conditioning the signal.

If a high impedance signal probe is to be used between the front panel bnc connectors and the measurement source, use a probe capable of compensating for the input capacitance of the counter (less than 24 pF). A probe is recommended for all digital logic applications; the TEKTRONIX P6125 has been designed specifically for these counters, and its use is recommended. The counter has been designed, however, to properly trigger on ECL signals even when a X10 attenuator probe is used.

MEASUREMENT CONSIDERATIONS

Input Coupling, Noise, and Attenuation

You can use either the ac coupling (AC COUPL) or dc coupling (DC COUPL) mode to couple the input signal to the CHANNEL A or CHANNEL B input amplifiers. If the signal to be measured is riding on a dc level, its amplitude limits may not fall within the triggering level range. The AC COUPL mode should be used for repetitive signals having a fixed frequency and a constant duty cycle, or for signals riding on a large dc level. Slope selection is relatively unimportant when measuring the frequency or period of sine-waves. The 50 Ω Termination is selected for high frequency 50 Ω systems, while 1 M Ω is selected for high impedance probes and

for other high impedance situations. When in 50 Ω , the internal termination resistor could be damaged if the user accidentally applied an overly large signal. To prevent this, the DC 5010 automatically reverts to 1 M Ω for most signals that might damage the 50 Ω resistor. See the Specification section for more detail.

If the signal frequency or duty cycle changes, the triggering point may shift, stopping the measurement process. Use the DC COUPL mode for low frequency ac signals, signals with a low duty cycle, and during any time interval measurement (Time A→B, Rise/Fall A, Events B Dur A, and Width A).

Noise may be coupled to the input amplifiers along with the signal to be measured. Noise may originate from the operating environment, the signal source, or be caused by improper connections. If the noise is of sufficient amplitude, it can result in inaccurate measurements due to false triggering. See Fig. 2-3. The DC 5010 has a 20 MHz low pass filter (FILTER) that is helpful in removing or reducing noise.

The linear operating range describes the voltage limits that will allow proper triggering without distortion. The minimum signal amplitudes are defined by the input sensitivity requirements for the AC COUPL and DC COUPL modes for either the 1 M Ω or 50 Ω Termination selection (see the Specification section). Proper use of the ATTN (attenuation) controls will ensure operation within the maximum limits; ± 2.0 V for X1 ATTN, ± 10 V for X5 ATTN.

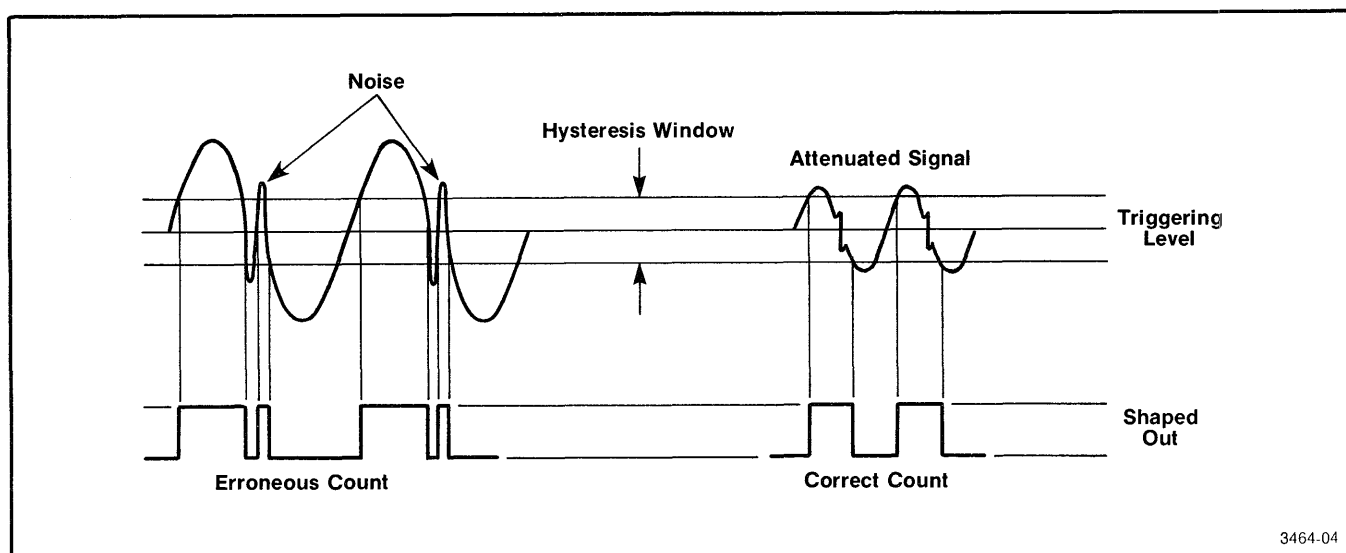


Fig. 2-3. Advantages in signal attenuation.

Triggering the Counter

The dc triggering level is determined by the SLOPE and LEVEL selection, or by the AUTO TRIG button.

The LEVEL CH A and CH B buttons, in conjunction with the increment (\uparrow), and decrement (\downarrow) buttons, are used to move the triggering hysteresis window continuously up or down through a ± 2.0 V range in 4 mV steps. The hysteresis window is typically 50 mV peak-to-peak. To determine the exact trigger level settings, push LEVEL CH A (or LEVEL CH B); the respective levels will be displayed. To return to the measurement cycle, press the LEVEL CH A or LEVEL CH B button again (whichever is lighted); pressing any function button will also return the instrument to the measurement mode.

When the AUTO TRIG button is activated, the microprocessor performs a software routine to determine the maximum and minimum limits of the Channel A and Channel B input voltage swings. Then the routine automatically sets the triggering levels of each channel to 50% (+24 mV for + slope, -24 mV for - slope) of its respective measured minimum and maximum values when making frequency, period, and totalize measurements. AUTO TRIG is also useful for pulse width measurements (WIDTH A mode) and TIME A \rightarrow B measurements. Successful use of the Auto Trig here requires signal amplitudes of at least twice the effective hysteresis. Thus, signals with amplitudes greater than 140 mV peak-to-peak are typically necessary. This is because the actual trip level of the hysteresis window is set exactly at the 50% point for Width and Time A \rightarrow B.

Figure 2-4 illustrates typical trigger level settings and shows the importance of setting trigger levels properly in order to avoid errors due to input signal risetimes (falltimes), or where the transition times of the start and stop pulses are different (or just slow). Observation of the SHAPED OUT signals on an oscilloscope, while setting the trigger levels on slow but complex waveforms, aids in reducing trigger setting difficulties.

The use of the Auto Trig, though very convenient, does not reduce the need to consider input noise amplitudes, coupling, impedance matching, and attenuation factors. Large amounts of overshoot and ringing of the input signal may cause erroneous counts due to an undesirable level setting. The median value of the input signal may be displayed. For mid-point settings, the low frequency limit for the Auto Trig mode is 10 Hz. Below 10 Hz, the automatic triggering level will still be set between the signals maximum and minimum, but not necessarily at the 50% point. For dc inputs, the level determination provided by auto trigger once again becomes correct.

Reducing Measurement Errors

As an aid in reducing measurement errors, keep in mind the following factors.

- Use the ATTEN controls and high impedance, attenuator type probes when measuring signals from high impedance circuits.
- Use the 50 Ω TERMination control for low impedance, high frequency 50 Ω systems.
- Consider trigger errors caused by input signals with slow rise or fall times.
- Use the 20 MHz FILTER to reduce high frequency noise.
- Average the measurement over a larger number of cycles of the input signal (greater number of AVGS)
- Maintain the counter environment at a constant temperature.
- For greater stability, allow extra instrument warm-up time ($> 1/2$ hour).
- Substitute the standard time base with the optional, higher stability time base.
- Apply a 1 MHz, 5 MHz, or 10 MHz external time reference standard (NBS) to the rear interface inputs.
- Recalibrate, if necessary.

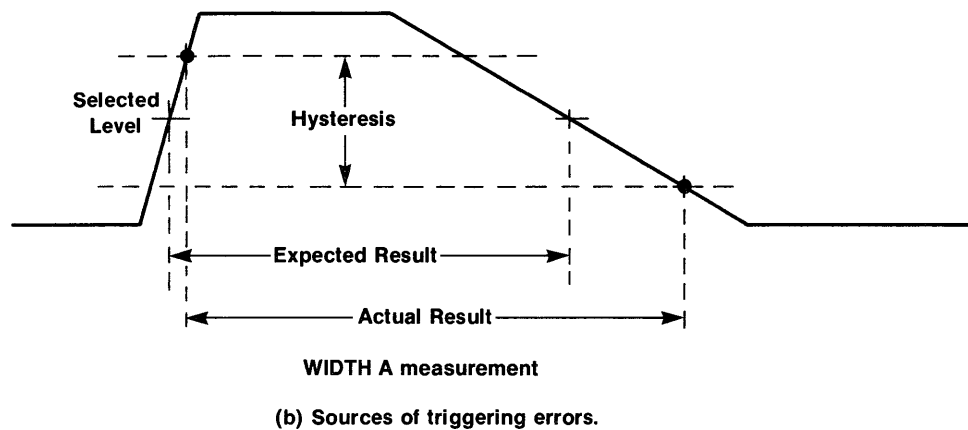
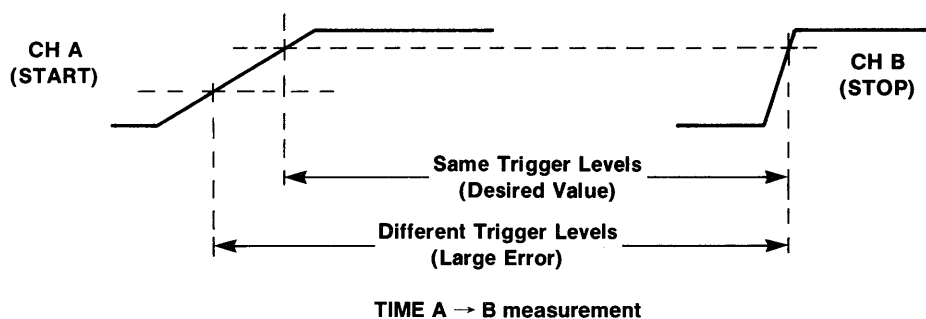
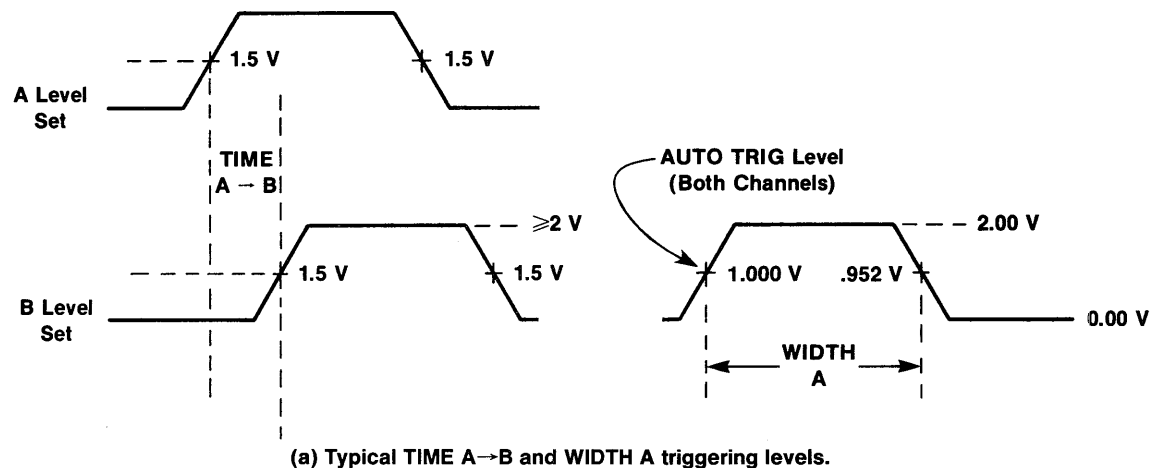
MEASUREMENT EXAMPLES

Frequency A and Period A

When the counter is in either the FREQ A or PERIOD A modes, it always measures the period of the Channel A input signal. For FREQ A, the microprocessor computes the frequency as:

$$f = \frac{1}{T} \quad (T = \text{period})$$

and displays the answer in frequency units. For PERIOD A, the answer is displayed in units of time. The 320 MHz internal clock insures very high resolution in both frequency and period. For period measurements of fast signals with 10^9 Averages, this resolution is ± 31.25 attosecs (31.25×10^{-18} sec).



(3464-05)3897-04

Fig. 2-4. Typical triggering levels and sources of triggering errors.

Ratio B/A

In Ratio B/A mode, the counter measures the number of events on both channels during the time it takes to accumulate the selected number of Channel A events (averaged by A events). The total number of Channel B events is then divided by the total number of Channel A events and the answer displayed without units of time or frequency.

The ratio range is from 10^{-8} to 10^9 . Applying the higher frequency to Channel B produces a ratio greater than one; applying the lower frequency to Channel B produces a ratio less than one. For better resolution, apply the higher frequency signal to Channel B.

Width A and Time A → B (Time Interval)

Figure 2-5 illustrates measurements for the WIDTH A and TIME A → B functions. The WIDTH A function measures the time interval between the first selected positive or negative edge (\pm SLOPE) of the waveform applied to Channel A and the next opposite polarity edge.

The TIME A → B function measures the time interval between the first selected occurrence (\pm SLOPE) of an event on Channel A to the first selected occurrence (\pm SLOPE) of an event on Channel B. The measurement can be averaged (AVGS) by the selected number of Channel A events because there is one Channel B event per Channel A event.

When either the WIDTH A, TIME A → B, or RISE/FALL A function is activated, the microprocessor turns on an internal pseudo-random noise generator that phase modulates the internal 3.125 ns time base, allowing the counter to measure without error, input signals that otherwise would be synchronous with its time base. See Fig. 2-5.

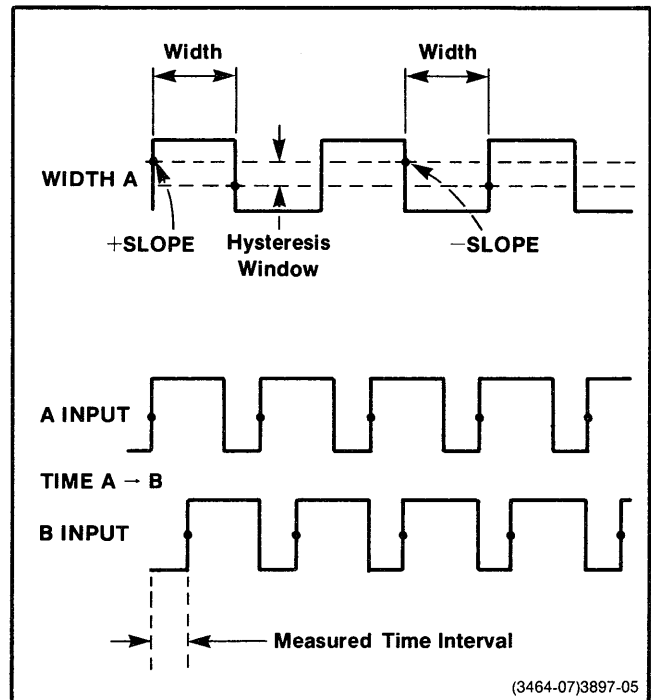


Fig. 2-5. Measurement examples for WIDTH A and TIME A → B.

In Fig. 2-6 the time interval (4.68525 ns, WIDTH A) would not be measured with a non-modulated time base any more accurately with averaging than it could have been by making a single-shot measurement (AVGS = 0). Using the pseudo-random phase-modulated clock pulses, and setting the AVGS switch greater than 1, causes the counter in this example to count one clock pulse one-half of the time and two clock pulses one-half of the time. For example, if AVGS is set to 10 (10^1) the total time for the count is at least

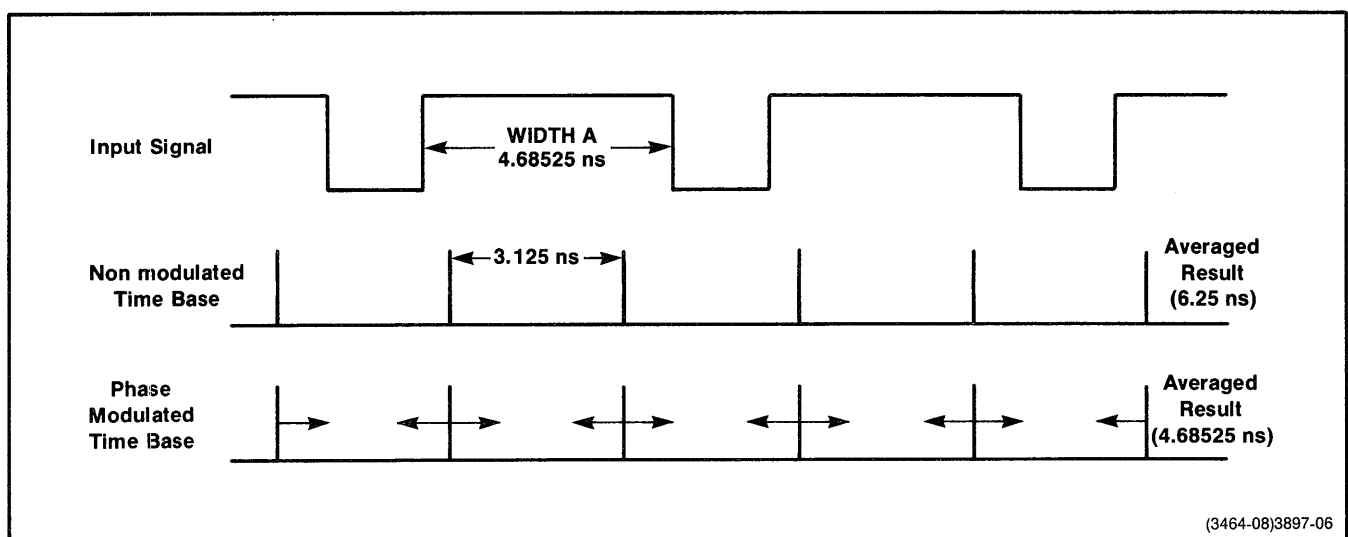


Fig. 2-6. Measurement example for synchronous input signals.

46.8525 ns. Ten averages yields 15 counts (5 counts + 10 counts). Dividing the total count by the number of averages, the average (count/interval) of each count corresponds to 3.125 nsec. The answer, is then $(15/10 \times 3.125 = 4.68525$, which on the DC 5010 would be displayed as 4.6 nsec.

Null

Pressing the NULL button stores the present measurement result and then subtracts that number from all subsequent measurements (while the button remains lighted). It is most useful in Time A \rightarrow B measurements, where it can be used to null out systematic errors (such as unequal cable lengths and channel mismatches); however, it is available in all measurement functions.

The averages setting may be changed without losing the Null stored measurement. If the instrument is subtracting two numbers of differing resolution, the result of such a subtraction has the resolution of the lesser resolution number. This is the number that the counter automatically uses to determine how many digits to display.

Pressing the button again will re-null the result.

To exit the Null mode, press any function button (including that of the function already chosen).

Events B During A

The EVENTS B DUR A function is basically the same as WIDTH A; except, instead of clock edges, the counter counts the selected number of positive-going or negative-going events (\pm SLOPE, CHANNEL B) occurring during a selected positive or negative pulse width occurring on Channel A (\pm SLOPE, CHANNEL A). Therefore, the internal time base is not counted for this function. See Fig. 2-7 for a measurement example. The Channel B events are averaged over the selected number (AVGS) of Channel A pulse widths.

Time Manual

The TIME MANUAL function measures and displays the time interval (to the closest one-hundredth of a second) between the first and second depressions of the MEASUREMENT START/STOP pushbutton. The time count can be reset to zero and restarted by pressing and then releasing the RESET pushbutton. The AVGS switch has no affect in the Time Manual mode. When first entering this function, the measurement is in the STOPPED mode, as indicated by the lighted START/STOP button.

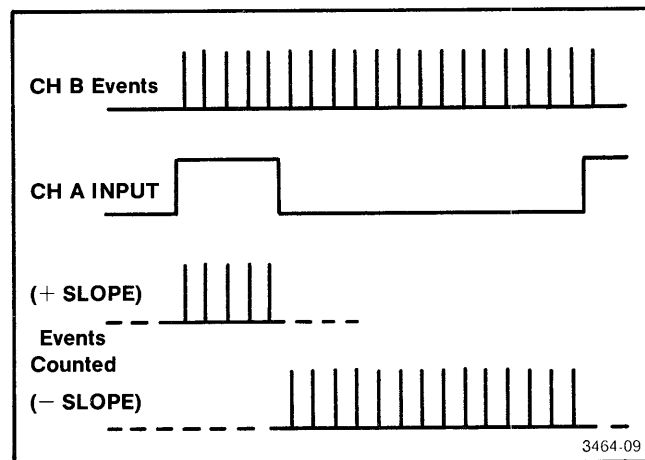


Fig. 2-7. Measurement example, EVENTS B DURING A.

Totalize A

The Total A function is basically the same as TIME MANUAL except that instead of counting the internal time base pulses, the counter counts the total number of Channel A events occurring between two successive depressions of the MEASUREMENT START/STOP pushbutton. The AVGS switch is active in this mode. With the AVGS exponent set to 0 or AUTO (-1), whole numbers are displayed. For other settings, AVGS operates as a power-of-ten scaling indicator (allowing totalizing to the full fourteen digits of the internal count chain). For example, with a 1 MHz input signal and the AVGS switch set to 10^6 , the least significant digit displayed would represent 10^6 counts and would increment at one count per second ($10^6 \text{ Hz}/10^6 = 1 \text{ Hz}$). This scaling factor may be changed (Refer to Text) after a measurement is over, effectively moving the display. This allows the user to view all thirteen digits of the count chain.

Totalize A+B

The TOTAL A+B function is as described for TOTAL A with the exception that the counter counts the total number of Channel A events plus the total number of Channel B events. The B count does not begin until after the first valid A count.

Totalize A-B

The TOTAL A-B function is similar to the TOTAL A+B function with the exception that the counter counts the total number of Channel A events minus the total number of Channel B events. The B count does not begin until after the first valid A count.

Risetime A and Falltime A

The RISE/FALL A function allows the operator to automatically measure the 10% to 90% risetime (or falltime) of the counter's specified input signal appearing on Channel A. See Fig. 2-8a. Select the SLOPE (+ = risetime; - = falltime) before pressing the RISE/FALL A button. The input signal size is automatically measured and the 10% and 90% levels are automatically calculated and set. These levels are available over the GPIB bus.

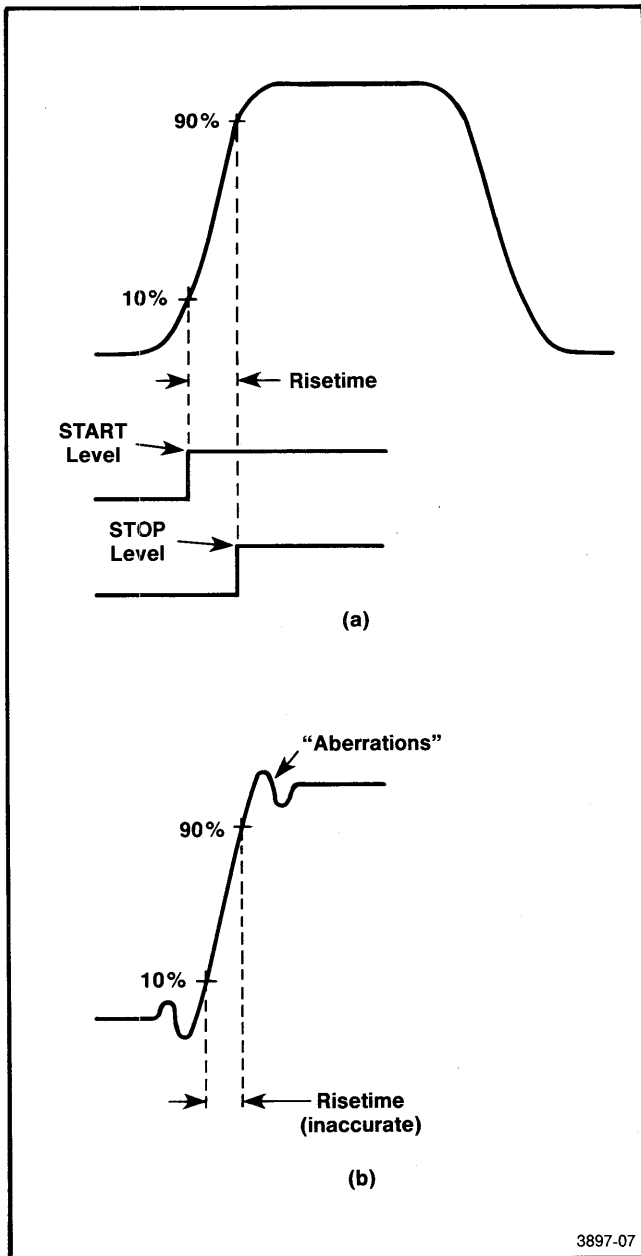


Fig. 2-8. Measurement example for risetime.

Internally, the A input is routed to both the A Channel and B Channel. The A Channel input conditioning is automatically duplicated (and indicated by the front panel lighted buttons) on the B Channel when the RISE/FALL A button is pressed. Although risetime measurements are simple to make, some operator problems can develop (even when using the automatic level setting capability of the counter). The signal being measured must satisfy the instrument requirements as detailed in the Specification section of this manual. The input signal amplitude must be greater than 1.4 V (50 Ω) or 700 mV (1 M Ω), have a risetime not less than 4 nsec (5 nsec for 1 M Ω), and not exceed 10% aberrations.

The DC 5010 uses a true peak detector circuit and detects the highest signal peak, even if the peak is an aberration (see Fig. 2-8b). If this aberration is too severe (greater than 10%), the instrument will not measure the correct risetime. Before pressing the RISE/FALL A button, the front panel FILTER (20 MHz) button can sometimes be selected to limit the internal risetime (less than 18 nsec) of the input signal to reduce these aberrations. Effective use of the filter will depend on the signal width and aberrations. Press the RISE/FALL A button. After the signal peak is measured and the 10% to 90% levels are set, the filter would be removed so the DC 5010 may display the actual unlimited risetime (without filter).

The counter front panel pushbuttons remain active after pressing the RISE/FALL A button, to enable the operator to modify signal input conditioning and trigger levels. The modified conditioning and levels must satisfy the instrument requirements as detailed in the Specification section of this manual.

For example, if the AUTO button is pressed (while in RISE/FALL A) the Channel A and Channel B levels will move from the 10% and 90% points to the 50% point. In the DC 5010 if the 20% and 80% risetime points are desired, MIN and MAX values (see the Programming notes in this section) are available over the GPIB bus. These values can be used to calculate these 20% and 80% risetime points and program them into the Channel A and Channel B.

Other specific signal levels such as TTL High or TTL Low can be programmed by the operator; however, consideration must be given for the termination setting. In the 50 Ω termination, the displayed trigger level is one-half the true trigger level due to the internal power splitter (not evident to the instrument). In the 1 M Ω termination the instrument does not take into account any attached probes (see Rise/Fall specification for level information with the use of probes).

Probe Compensation

The DC 5010 has been specifically designed to be compatible with standard probes when in 1 M Ω termination; however, the operator must still be sure that the probe is properly compensated.

In the DC 5010, a probe compensation (PROBE COMP) function is built into the counter. It allows the user to compensate the probe in place and without the use of an external oscilloscope.

A square-wave signal of approximately 1 kHz and an amplitude of approximately 5 V is provided at the front panel PROBE COMP tip jack.

Connect the probe tip to the PROBE COMP tip jack before entering the PROBE COMP mode.

The counter should display a zero for the most significant digit (far left) and a zero for the least significant digit (far right). The far left digit is for a probe connected to CHANNEL A and the far right digit for a probe connected to CHANNEL B. No decimal points or annunciators should be illuminated.

With the probe connected and the square-wave signal applied, perform the following steps.

1. Slowly rotate the probe adjustment in either direction until the display changes to a continuous 1 reading for the channel being compensated.

2. Slowly reverse the rotation of the probe adjustment until the display *just goes back to a 0*. At this point, the probe will be compensated. A 1 indicates that the probe is over compensated; a 0 indicates under compensation. Final adjustment should be made in the direction where the 1 just changes to a 0.

NOTE

If a display goes to a 1 and remains in that condition for one or more complete revolutions of the probe adjustment, press the RESET pushbutton to clear the condition. This can occur if the connection to the square-wave source became open during the adjustment procedure.

Test Function

A 000 display in the three MSD's for the TEST function is an indication that the microprocessor has checked itself. The test also checks the internal serial data path, the integrity of the internal counter chain (accumulators), and, as a by-product, the operation of the digital-to-analog converter (trigger levels) and input amplifier circuits.

The random-access memory space (RAM) is not checked during this front panel self-test; the RAM is checked only at power-up.

NOTE

If the CHANNEL A or CHANNEL B inputs are connected, the peaks of the input signals must be within the triggering level range of the counter for the test function to operate properly. If a failure occurs, first disconnect any CHANNEL A or CHANNEL B inputs and repeat the test. A connection to the arming input may also cause improper operation.

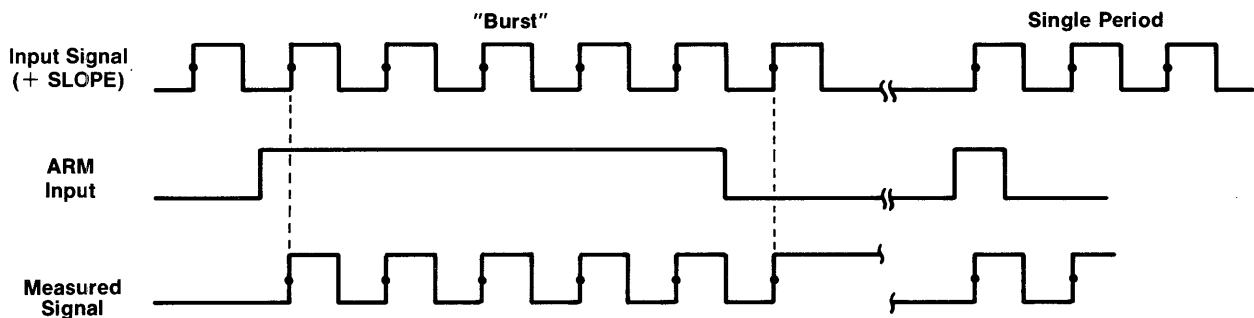
The gate light will flash once each time a full test cycle has been completed. If a failure is ever noted, the error code of that failure will be displayed in the three extreme left digits of the seven-segment display and the cycling will halt. The DC 5010 will stay in test mode until another function is selected.

Arming (ARM Input)

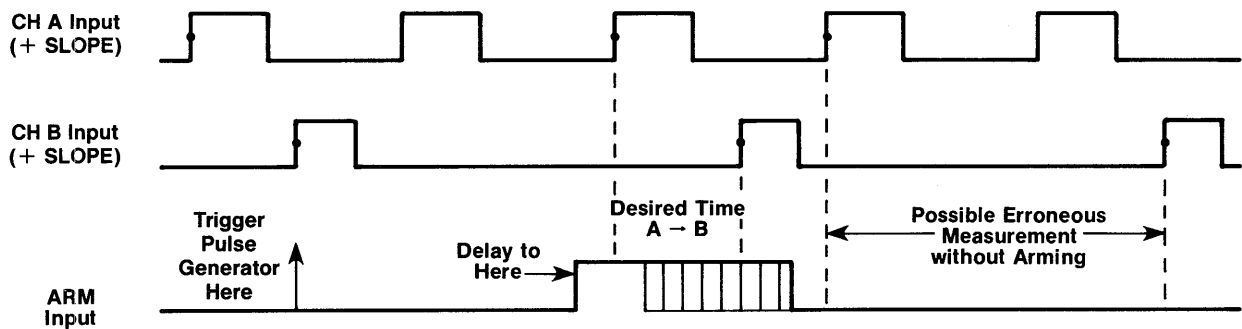
Arming provides a means by which single events or sets of events can be selected for measurement within a complex analog or digital signal. Figure 2-9 shows three different examples of arming.

The ARM input requires TTL signal levels. With no signal attached the ARM input is normally pulled high and is thus continuously armed. When the ARM input is pulled low, the counter is prevented from starting a measurement. Arming may be used in all measurement functions with the exception of TIME MANUAL, PROBE COMP, and TEST. In these three functions the ARM signal must be high.

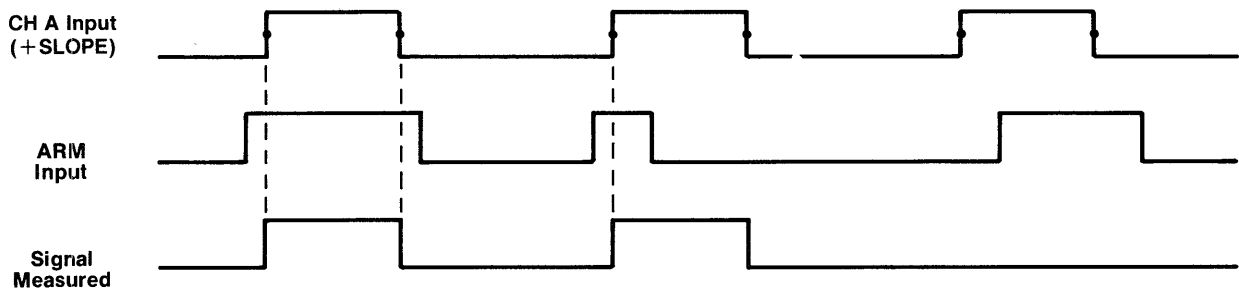
When the arming signal changes to a high state, the first subsequent Channel A event will start the measurement process. When the arming signal changes to a low state, the next Channel A event will stop the measurement process. Therefore, the counter can be controlled as to when, in time, a measurement will be made (even in complex waveforms).



a. Use of ARM with FREQ, PERIOD, and RATIO functions.



b. Use of a triggered delay pulse generator to generate a TIME A → B arming signal.



c. Use of ARM with WIDTH A and EVENTS B DUR A functions.

(3464-10)3897-08

Fig. 2-9. Examples of arming.

These armed measurements can then be averaged much like time interval averaging. The counter determines the number of digits to display (best possible resolution) based on the number of Channel A events averaged. Typically, each total measurement of Frequency, Period, and Ratio contains a 1 count error and the counter displays the number of digits that can be justified given this error. When using arming in the Frequency Period, or Ratio modes (non-time interval modes), each act of arming and disarming can introduce 1 count errors. The counter does not take this into account, however, and displays the number of digits based only on the total number of events per overall measurement, independent of the number of times the instrument was armed and disarmed.

The actual resolution for a period measurement using arming will be less than that displayed. It can be found using the following relationship:

$$\text{Resolution} = \frac{T_c}{N} \frac{\sqrt{N} T_p}{T_B}$$

T_c = clock period

T_p = input period (CH A)

T_B = time from starting A event to stopping A event

N = number of averages, i.e., 10^6 or 10^9 , etc.

PROGRAMMING

Introduction

This section of the manual provides information for programming the DC 5010 by remote control via the IEEE-488 General Purpose Interface Bus (GPIB). The following information assumes the reader is knowledgeable in GPIB communication and has some exposure to programming controllers. Communication via the GPIB is specified and described in the IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation"¹ All GPIB references in this manual refer to the IEEE-488 GPIB. TM 5000 instruments are designed to communicate with any GPIB-compatible controller that sends and receives ASCII messages (commands) over the GPIB. These commands program the instrument or request information from the instrument.

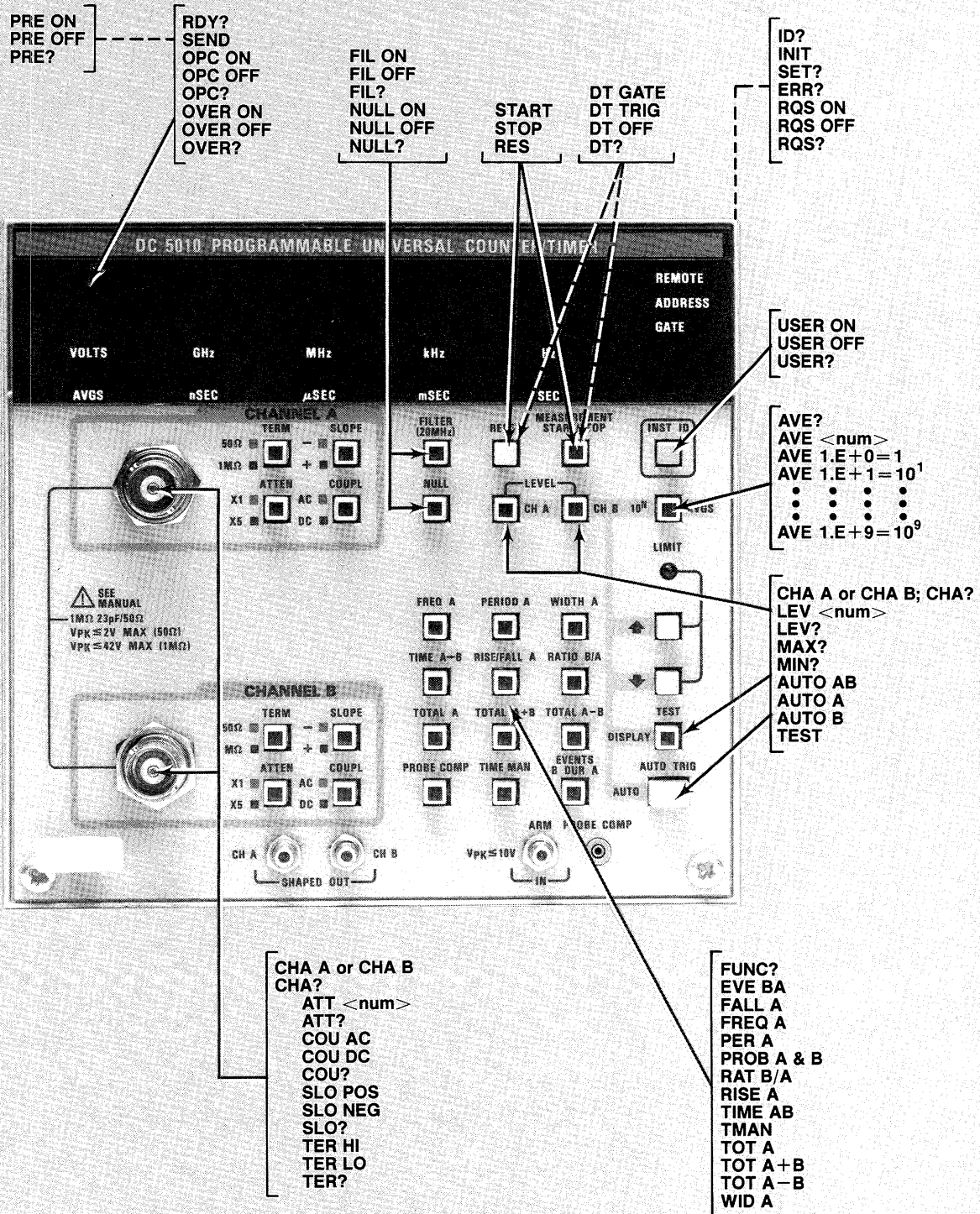
Commands for TM 5000 programmable instruments are designed for compatibility among instrument types. The same command is used in different instruments to control similar functions. In addition, commands are specified in mnemonics related to the functions they implement. For example, the command INIT initializes instrument settings to their power-up states. For further ease of programming, command mnemonics match those on the front panel in most cases.

¹ Published by the Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, N.Y., 10017.

Instrument commands are presented in three formats:

- A front panel illustration—showing command relationships to front panel operation (see Fig. 2-10).
- Functional Command List—a list divided into functional groups with brief descriptions.
- Detailed Command List—an alphabetical listing of commands with complete descriptions.

TM 5000 programmable instruments connect to the GPIB through a TM 5000 power module. Refer to Installation and Removal earlier in this section for information on installing the instrument in the power module. Also, review the Front Panel Operation portions of this section to become familiar with front panel and internally selectable instrument functions. The GPIB primary address for this instrument may be internally changed by qualified service personnel. The DC 5010 is shipped with the address set to decimal 20. The message terminator may also be internally selected by qualified service personnel. Message terminators are discussed in Messages and Communication Protocol (in this section). TM 5000 instruments are shipped with this terminator set to EOI ONLY. Refer qualified service personnel to the Maintenance section of this manual for locations and setting information. Pressing the INST ID button causes the instrument to display its selected GPIB primary address; the far right decimal point lights if the selected message terminator is LF/EOI.



3897-09

Fig. 2-10. Quick command list.

COMMANDS

The instrument is controlled by the front panel or via commands received from the controller. These commands are of three types:

Setting commands—control instrument settings.

Query-output commands—ask for data.

Operational commands—cause a particular action.

The instrument responds to and executes all commands when in the remote state. When in the local state, *setting* and *operational commands* generate errors since instrument functions are under front panel control; only *query-output commands* are executed.

Each command begins with a header—a word that describes the function implemented. Many commands require an argument following the header, a word or number which specifies the desired state for the function.

CAUTION

Using fewer characters than the abbreviated header or argument should be done with caution since erroneous results or damage could result if this data is sent to the wrong instrument.

FUNCTIONAL COMMAND LIST

INSTRUMENT COMMANDS

Function Commands

EVE BA	– Counts Channel B during Channel A pulse width
FALL A	– Measures the falltime of the signal on Channel A
FREQ A	– Measures frequency of input signal on Channel A
FUNC?	– Query returns current instrument function
PER A	– Measures period of Channel A signal
PROB A&B	– Enables probe compensation
RAT B/A	– Measures ratio of B events to A events
RISE A	– Measures the risetime of the signal on Channel A
TEST	– Tests ROM, I/O, accumulator
TIME AB	– Measures time from A event to B event
TMAN	– Manual timing function (stop watch)
TOT A	– Totalizes Channel A events
TOT A+B	– Measures the total number of events on Channel A plus the total of events on Channel B
TOT A–B	– Measures the total number of events on Channel A minus the total number of events on Channel B
WID A	– Measures pulse width of Channel A signal

Measurement Control

AVE or AVGS	– Sets number of measurements averaged (in decades only), or auto averaging
AVE? or AVGS?	– Query returns AVE <num>; (–1 for AUTO Averages)
NULL ON	– Subtracts present measurement results from all succeeding measurements
NULL OFF	– Resets Null value
NULL ?	– Query returns NULL ON or NULL OFF
RDY?	– Query returns RDY 1 for new data ready or RDY 0 for new data not ready
RES	– Resets counters, restarts current measurement
START	– Starts TMANual, STOPped, or TOTAlize measurement
STOP	– Stops any measurement except TEST or PROBECOMP

INPUT/OUTPUT CONTROL

ATT 1 or 5	– $\times 1$ or $\times 5$ Attenuation
ATT?	– Query returns ATT <num>
AUTO A	– Sets trigger level to signal midpoint (CH A)
AUTO B	– Sets trigger level to signal midpoint (CH B)
AUTO A&B	– Sets trigger level to signal midpoint (Both channels)
CHA A or B	– Selects channel for succeeding input settings
CHA?	– Query returns CHA A or CHA B
COU AC or DC	– Sets input coupling mode
COU?	– Query returns COU AC or COU DC
FIL ON	– Limits the channel A and B bandwidth to approximately 20 MHz
FILL OF	– Turns off filter
FIL ?	– Query returns FIL ON at FIL OFF
LEV	– Sets selected channel trigger level Num range = $+2.000$ to $-2.000 (\times 1)$ or $+10.000$ to $-10.000 (\times 5)$
LEV?	– Query returns trigger level setting of selected channel
MAX?	– Query returns last AUTOTrig maximum peak voltage
MIN?	– Query returns last AUTOTrig minimum peak voltage
PRE ON	– Enables prescaler and internal scaling
PRE OFF	– Disables prescaler and internal scaling
PRE?	– Query returns PRE ON or PRE OFF
SEND	– Obtains and formats new measurement results
SLO POS	– Triggers on positive slope
SLO NEG	– Triggers on negative slope
SLO?	– Query returns SLO NEG or SLO POS
TER HI	– Sets channel input to termination 1 megohm, 23 pF
TER LO	– Sets channel input termination to 50 Ω
TER?	– Query returns TER HI or TER LO

SYSTEM COMMANDS

DT GATE	– <GET> controls Start and Stop
DT TRIG	– <GET> performs RESET
DT OFF	– Disables Device Trigger
DT?	– Query returns DT TRIG, DT OFF, or DT GATE
ERR?	– Returns error code for most recent event reported by serial poll when RQS is ON; with RQS OFF it returns the highest priority status
ID?	– Query returns instrument type and firmware versions
INIT	– Initializes instrument to power-on settings
SET?	– Query returns current instrument settings
TEST	– Tests ROM, I/O, accumulator

STATUS COMMANDS

OPC ON	– Enables assertion of SRQ on OPERATION COMPLETE
OPC OFF	– Disables SRQ on OPERATION COMPLETE
OPC?	—Query returns OPC ON or OPC OFF
OVER ON	—Enables asserting of SRQ on counter overflow
OVER OFF	—Disables SRQ on counter overflow
OVER?	—Query returns OVER ON or OVER OFF
RQS ON	—Enables SRQ assertion
RQS OFF	—Disables SRQ assertion and clears SRQ
RQS?	—Query returns RQS ON or RQS OFF
USER ON	—Enables asserting of SRQ when INST ID button is pushed
USER OFF	—Disables asserting of SRQ when INST ID is pushed
USER?	—Query returns USER ON or USER OFF

DETAILED COMMAND LIST

ATTENUATION

Type:

Setting or Query

Setting Syntax:

ATT <number>

Examples:

ATT .999999
 ATT 5.00001
 ATTENUATION 1

Query Syntax:

ATT?

Query Response:

ATT 1;
 ATT 5;

Discussion:

The ATTENUATION command sets the input signal attenuation for the selected channel to $\times 1$ (no attenuation) or $\times 5$. The argument is rounded to an integer and if it is not a 1 or a 5 an execution error (ERR 205) is issued indicating the argument is out of range.

The power-on initial setting is ATT 1.

For information on selecting channels see discussion of the CHANNEL command.

ATTENUATION

AUTOTRIG

Type:

Operational

Syntax:

AUTO A
 B
 A&B (argument is optional)

Examples:

AUTO
 AUTO A
 AUTOTRIG A&B

Discussion:

The AUTOTRIG command causes the DC 5010 to automatically set the trigger levels for channels to the approximate midpoints of the input signals. The maximum and minimum peak values for both channels are saved and may be read out using the MAX? and MIN? queries. The AUTOTRIG command accepts the following valid arguments:

- A — Automatically sets trigger level for Channel A only. Saves minimum and maximum peak values for both channels.
- B — Automatically sets trigger level for Channel B only. Saves minimum and maximum peak values for both channels.
- A&B — Automatically sets trigger levels for both channels. Also saves minimum and maximum peak values for both channels.

If no argument is specified, AUTO A&B is assumed.

When an AUTOTRIG is performed, previously set trigger levels for affected channels are replaced by the new values. These new values may not be at the midpoints if the input signals are outside the range of the instrument. Previously measured minimum and maximum peak values for both channels are always replaced.

The time required for the AUTOTRIG operation to complete is dependent on both Channel A and Channel B amplitudes and frequencies. Worst case time is approximately 2.5 seconds.

The following command sequence causes an AUTO TRIGGER to be performed and the resulting trigger levels to be output when the AUTOTRIG completes:

AUTO;CH A;LEV?;CH B;LEV?

AUTOTRIG

AVERAGES**Type:**

Setting or Query

Setting Syntax:

AVE <number>
or
AVGS <number>

Examples:

AVE -1
AVGS 1.E+2
AVERAGES 100

Query Syntax:

AVE? or AVGS?

Query Response:

AVE -1;
AVE 1.E+4;

Discussion:

The AVERAGES command sets the minimum number of events to be counted on Channel A before calculating measurement results. Valid <number> arguments are:

<number> ≤ 0 — Sets DC 5010 to “auto-averages” mode. In “auto-averages”, the instrument accumulates counts for ≈.3 seconds.

When in “auto-averages” query returns AVE -1.

<number> = 1, 1.E+1, 1.E+2, 1.E+3, 1.E+4, 1.E+5, 1.E+6, 1.E+7, 1.E+8, 1.E+9.

The argument <number> is first rounded to the nearest power of ten. If the resulting value is not one of the above valid values, the averages setting is left unchanged and an execution error (ERR 205) is issued.

The AVERAGES setting is also used to scale the displayed results for TOTALIZE measurements. Results output to the IEEE-488 bus, however are not scaled.

The power-on initial settings is AVE -1.

AVERAGES**CHANNEL (CHANNEL SELECT)****Type:**

Setting or Query

Setting Syntax:

CHA A
B

Examples:

CHANNEL A
CHA B

Query Syntax:

CHA?

Query Response:

CHA A;
CHA B;

Discussion:

The CHANNEL command selects the channel that the subsequent input setting commands affect. The input settings commands are SLOPE, SOURCE, ATTENUATION, COUPLING, and LEVEL. Valid arguments are:

A — Channel A is affected by input setting commands.

B — Channel B is affected by input setting commands.
The power-on initial setting is CHA A.

CHANNEL (CHANNEL SELECT)

COUPLING**Type:**

Setting or Query

Setting Syntax:COU AC
DC**Examples:**COUPL AC
COU DC**Query Syntax:**

COU?

Query Response:COU AC;
COU DC;**Discussion:**

The COUPLING command sets the input signal coupling for the selected channel. Valid arguments are:

- AC — Select ac coupling for input signal.
- DC — Select dc coupling for input signal.

When switching from DC Coupling to AC Coupling or when the dc level of an input signal changes and the signal is ac coupled, the following settling times are required:

- ×1 probe connected — 1.0 seconds
- ×5 probe connected — 2.5 seconds
- ×10 probe connected — 5.0 seconds

The above times specify the time until the Coupling capacitor is charged to within 1% of its final value and assumes the source has a very low impedance.

The power-on initial setting is COU DC.

For information on selecting channels see discussion of the CHANNEL command.

COUPLING**DT (DEVICE TRIGGER)****Type:**

Setting or Query

Setting Syntax:DT GATE
TRIG
OFF**Examples:**DT GATE
DT TRIG
DT OFF**Query Syntax:**

DT?

Query Response:DT GATE
DT TRIG
DT OFF**Discussion:**

The DT command controls the instrument's response to the GROUP EXECUTE TRIGGER <GET> interface message. The valid arguments are:

- GATE — In this Device Trigger mode, <GET> controls the STARTing and STOPping of the measurement. If measurement is STOPped, <GET> will START measurement. When STARTed, <GET> will STOP the measurement.
- TRIG — In this Device Trigger mode, <GET> causes a measurement RESET to be performed. If the measurement is already STARTed, this causes it to be reset and restarted. If the measurement is currently STOPped, this causes a single measurement to be initiated.
- OFF — In this mode a <GET> causes instrument to issue an execution error (ERR 206).

The power on initial setting is DT OFF.

DT (DEVICE TRIGGER)

ERROR**Type:**

Query

Syntax:ERR?
ERROR?**Response:**

ERR <number>;

Discussion:

The ERROR query is used to obtain information about the status of the instrument.

If RQS is ON, the ERROR query returns an event code <number> describing why the RQS bit was set in the last Status Byte reported by the instrument. The event code is then reset to 0.

If RQS is OFF, the ERROR query returns an event code <number> describing the highest priority condition currently pending in the instrument. This event code is then cleared and another ERROR query will return the event code for the next highest priority condition pending.

EVENTS (EVENTS B DURING A)**Type:**

Operational

Syntax:

EVE BA (argument is optional)

Examples:EVENTS BA
EVE**Discussion:**

The EVENTS command sets up the DC 5010 to measure the total number of events occurring on Channel B during the pulse width of the input signal on Channel A.

ERROR**EVENTS (EVENTS B DURING A)**

FALLTIME

Type:

Operational

Syntax:

FALL A (argument is optional)

Examples:

FALL
FALLTIME A

Discussion:

The FALLTIME command sets up the instrument to measure the faltime of the input signal on Channel A. CHANNEL A SLOPE is automatically set to — and the CHANNEL B ATTEN, COUPL, SLOPE, and TERM settings are updated to match those of CHANNEL A. The CHANNEL A input signal is internally routed through both Channels A and B input circuits and then the 90% and 10% trigger level points are determined and set.

The Faltime function uses the autotrigger operation to determine the 10% and 90% points. Therefore, the trigger levels and the minimum and maximum peak values are affected by Faltime measurements.

FALLTIME

FILTER

Type:

Setting

Syntax:

FIL ON
OFF

Examples:

FIL ON
FILTER OFF

Query Syntax:

FIL?

QUERY Response:

FIL ON:
FIL OFF:

Discussion:

The FILTER command controls the setting of the high frequency noise filter. Valid arguments are:

ON — Sets high frequency noise filter to limit bandwidth of both channels to 20 MHz.

OFF — Resets high frequency noise filter to allow full 350 MHz bandwidth.

The power-on initial setting is FIL OFF

FILTER

FREQUENCY**Type:**

Operational

Syntax:

FREQ A (argument is optional)

Examples:FREQUENCY A
FREQ**Discussion:**

The FREQUENCY command sets up the DC 5010 to measure the frequency of the input signal on Channel A.

This is the power-on function setting.

FUNCTION**Type:**

Query

Syntax:FUNC?
FUNCTION?**Response:**EVE BA;
FALL A;
FREQ A;
PER A;
RAT B/A;
TIME AB;
TMAN;
TOT A;
TOT A+B;
TOT A-B;
WID A;
PROB A&B;
RISE A;
TEST;**Discussion:**

The FUNCTION query returns one of the responses shown above. The response indicates the measurement function currently selected.

FREQUENCY**FUNCTION**

IDENTIFY

Type:

Query

Syntax:

ID?
IDENTIFY?

Response:

ID TEK/DC5010,V79.1,Fx.y;

Discussion:

The IDENTIFY query returns the above response where:

TEK/DC 5010 — Identifies the instrument type.

V79.1 — Identifies the version of Tektronix Codes and Format Standard to which the instrument conforms.

Fx.y — Identifies the firmware version of the instrument, where x.y is a decimal number.

INITIALIZE

Type:

Operational

Syntax:

INIT
INITIALIZE

Discussion:

The INIT command performs a power-on initialization of the instrument's settings. The power-on settings for the DC 5010 are:

FREQ A
AVE — 1
FIL OFF
NULL OFF
SLO POS (Channels A&B)
ATT 1 (Channels A&B)
COU DC (Channels A&B)
TERM HI (Channels A&B)
CHA A
OPC OFF
OVER OFF
PRE OFF
DT OFF
USER OFF
RQS ON

In addition, an autotrigger is performed to set the trigger levels. With the maximum and minimum peak values of autotrigger performed, the maximum execution time for the INIT function is 2.5 seconds.

The INIT command does not generate a power-on SRQ nor does it put the instrument in LOCAL mode as a normal power-on does.

IDENTIFY

INITIALIZE

LEVEL (TRIGGER LEVEL)

Type:

Setting or Query

Setting Syntax:

LEVEL <number>

Examples:

LEVEL -1.025
LEV 0.005
LEV 7.5

Query Syntax:

LEV?

Query Response:

LEV -1.025;
LEV 0.000;

Discussion:

The LEVEL command sets the trigger level of the previously selected channel to the value specified. The value is expressed in volts and has a range of -2.000 to 2.000 when in $\times 1$ attenuation and -10.000 to 10.000 when in $\times 5$ attenuation. The resolution is 0.004 for $\times 1$ attenuation and 0.020 for $\times 5$ attenuation.

The value is rounded to the nearest step and if this is not within the range of the DC 5010 the trigger level is left unchanged and an execution error (ERR 205) is issued.

For information on selecting Channels, see discussion of the CHANNEL command.

MAXIMUM

Type:

Query

Syntax:

MAX?
MAXIMUM?

Response:

MAX <number>;

Discussion:

The MAX? query returns a value indicating the maximum input signal voltage for the selected channel measured during the last autotrigger cycle. If the signal has changed and/or the input signal conditioning has changed since the last autotrigger, another AUTOTRIG is required to obtain the new MAX values.

An autotrigger cycle occurs for each AUTOTRIG, PROBEComp, RISE, or FALL operation. The maximum execution time for each operation is 2.5 sec, (1.5 sec, typical).

LEVEL (TRIGGER LEVEL)

MAXIMUM

MINIMUM

Type:

Query

Syntax:

MIN?

Response:

MIN <number>

Discussion:

The MINIMUM? query returns a value indicating the minimum input signal voltage for the selected channel measured during the last autotrigger cycle. If the signal has changed and/or the signal conditioning has changed since the last autotrigger, another AUTOTRIG is required to obtain the new MIN values.

An autotrigger cycle occurs for each AUTOTRIG, PROBEComp, RISE, or FALL operation. The maximum execution time for each operation is 2.5 sec, (1.5 sec, typical).

NULL

Type:

Operational

Syntax:

NULL ON
NULL OFF

Examples:

NULL ON
NULL OFF

QUERY Syntax:

NULL?

Query Response:

NULL ON;
NULL OFF;

Discussion:

The NULL command controls the storing of measurement results to be subtracted from all subsequent measurements. Valid arguments are:

ON — Store current measurement result and subtract it from all following measurements.

OFF — Reset stored Null value.

The Null value is reset each time the NULL OFF command is executed and each time a FUNCTION COMMAND IS EXECUTED. For Time interval measurement (TIME, WIDTH, RISE, FALL) the Null value is reset to 5.2 nsec to provide compensation for propagation delay time between Channels A and B input circuitry. For all other measurements, the Null value is reset to 0.

The power-on initial setting is NULL OFF.

MINIMUM

NULL

OPC (OPERATION COMPLETE)**Type:**

Setting or Query

Setting Syntax:

```

OPC ON
    OFF

```

Examples:

```

OPC ON
OPC OFF

```

Query Syntax:

OPC?

Query Response:

```

OPC ON;
OPC OFF;

```

Discussion:

The OPC command controls the asserting of SRQ when a measurement is completed. This command allows a controller to start a measurement, and then process some other task while waiting for an SRQ to inform it that measurement data is ready.

When OPC is ON and a measurement completes, SRQ is asserted and remains asserted until the status is read via a serial poll or until cleared by RQS OFF or a Device Clear. Operation Complete is indicated by a Status Byte of 66 or 82 and an ERROR query response of ERR 402.

For more Status Byte and ERROR information, see "Error and Status Reporting".

The Power on initial setting is OPC OFF.

OPC (OPERATION COMPLETE)**OVERFLOW****Type:**

Setting or Query

Setting Syntax:

```

OVER ON
    OFF

```

Examples:

```

OVER ON
OVERFLOW OFF

```

Query Syntax:

OVER?

Query Response:

```

OVER ON;
OVER OFF;

```

Discussion:

The OVERFLOW command controls the asserting of SRQ when the internal counting capacity of the DC 5010 is exceeded. This command allows the controller to detect and to respond to overflow conditions.

When making measurements, the DC 5010 uses two internal 43-bit counters, one for Channel A and one for Channel B.

For EVENTS, FREQUENCY, PERIOD, RATIO, TIME, or WIDTH measurements, OVERFLOW usually indicates that one of the input channels is not set up properly.

For TMANUAL and TOTALIZE measurements, OVERFLOW can easily be used by the controller to extend the range of the measurement. When making TMANUAL measurements, an OVERFLOW indicates that the Channel B counter has counted 2^{43} internal time base pulses (≈ 87960.9 seconds). When making TOTALIZE measurements, an OVERFLOW indicates that the Channel A counter has counted 2^{43} ($\approx 8.8 \times 10^{12}$) on the Channel A input. For both TMANUAL and TOTALIZE, the measurement result is reset and the measurement continues after an overflow is detected.

PROBECOMP and TEST measurements do not generate overflow conditions.

When OVERFLOW is ON and the instrument's internal capacity is exceeded, SRQ is asserted and remains asserted until the status is read via a serial poll or until cleared by RQS OFF or a Device Clear. Channel A overflow is indicated by a Status Byte of 193 or 209 and an ERROR query response of ERR 711. Channel B overflow is indicated by a Status Byte of 194 or 210 and an ERROR query response of ERR 712.

The power-on initial state is OVER OFF.

OVERFLOW

PERIOD

Type:

Operational

Syntax:

PER A (argument is optional)

Example:

PERIOD A
PER

Discussion:

The PERIOD command sets up the DC 5010 to measure the period of the input signal on Channel A.

PRESALE

Type:

Setting or Query

Setting Syntax:

PRE ON
PRE OFF

Examples:

PRESALE ON
PRE OFF

Query Syntax:

PRE?

Query Response:

PRE ON;
PRE OFF;

Discussion:

The PRESALE command multiplies the Channel A count by 16 before calculating FREQUENCY, PERIOD, RATIO, and TOTALIZE. This command should be used when a divide by 16 prescaler is attached to Channel A, otherwise erroneous measurements will result. Valid arguments are:

- ON — The Channel A input is multiplied by 16 before calculating results.
- OFF — The Channel A input is not scaled before the results are calculated.

When the PRESALE command is used and a compatible prescaler is not connected to the DC 5010 an execution warning (ERR 604) is issued.

The power-on initial setting is PRE OFF.

PERIOD

PRESALE

PROBECOMP (PROBE COMPENSATION)**Type:**

Operational

Syntax:

PROBE A&B (argument is optional)

Examples:PROBECOMP A&B
PROB**Discussion:**

The PROBE COMP command sets up the DC 5010 to provide information which can be used to help compensate probes.

This function generates 2-digit results. The most significant digit is the result for Channel A and the least significant digit is the result for Channel B.

The PROBECOMP function uses the autotrigger operation in the compensation process. Therefore, trigger levels and MIN and MAX values will be affected by PROBECOMP measurements.

The autotrigger, used by PROBECOMP, is a fast version of auto, with f_{\min} approximately 100 Hz and maximum execution time approximately 0.25 second. This fast auto may be used to quickly update MIN and MAX values for signals greater than 100 Hz.

For more information see description of Probe Compensation in this manual.

RATIO**Type:**

Operational

Syntax:

RAT B/A

Examples:RATIO B/A
RAT**Discussion:**

The RATIO command sets up the DC 5010 to measure the ratio of events on Channel B to the events on Channel A.

PROBECOMP (PROBE COMPENSATION)**RATIO**

RDY (DATA READY)

Type:

Query

Syntax:

RDY?

Response:

RDY 0;

RDY 1;

Discussion:

The RDY query returns "data ready" status. If the value returned is 0, measurement data is not currently available. If the value returned is 1, measurement data is available.

When measurement data is not available and the DC 5010 is "talked" by the controller, the instrument responds in one of two ways. If "talked" after receiving the SEND command and data is not ready, the DC 5010 waits for data to become ready and then sends it. If "talked" and the instrument has not received the SEND command and data is not ready, the DC 5010 responds by sending FF₁₆ (all data lines asserted).

Data becomes ready when a measurement is completed. It remains ready until the data is read out of the instrument or until an instrument setting, except averages, is changed. Data Ready is also cleared by a RESET.

RDY (DATA READY)

RESET

Type:

Operational

Syntax:

RES

RESET

Discussion:

The RESET command resets the instrument's count chains and initiates a new measurement. For EVENTS, FALL, FREQUENCY, PERIOD, RATIO, RISE, TIME, OR WIDTH measurements, a single result is determined if the measurement had been "STOPped" before the RESET. For PROBEComp measurement, RESET clears current compensation status and restarts compensation process. For TMAN and TOTALIZE measurements, counts are reset to zero and a new measurement is restarted if not "Stopped" before the RESET. For TEST measurement, RESET clears any existing error result and restarts TEST process.

RESET

RISETIME**Type:**

Operational

Syntax:

RISE A (argument is optional)

Examples:RISETIME A
RISE**Discussion:**

The RISETIME command sets up the instrument to measure the risetime of the input signal on Channel A. CHANNEL A SLOPE is automatically set to + and the CHANNEL B ATTN, COUPL, SLOPE, and TERM settings are updated to match those of CHANNEL A. The CHANNEL A input signal is internally routed through both Channels A and B input circuits, and then the 10% and 90% trigger level points are determined and set.

The Risettime function used the autotrigger operation to determine the 10% and 90% points. Therefore, the trigger levels and the minimum and maximum peak values are affected by Risettime measurements.

RQS (REQUEST FOR SERVICE)**Type:**

Setting or Query

Setting Syntax:RQS ON
RQS OFF**Examples:**RQS ON
RQS OFF**Query Syntax:**

RQS?

Query Response:RQS ON;
RQS OFF;**Discussion:**

The RQS command is a global control for assertion of SRQ by the DC 5010. When RQS is OFF the DC 5010 will not assert SRQ under any circumstance. When RQS is ON the DC 5010 is allowed to assert SRQ under appropriate circumstances; i.e., errors, operation complete, etc.

The ERROR? query can be used while RQS is OFF to see if any SRQ type conditions have occurred.

SRQ will be asserted for any previously unreported SRQ event when RQS is turned ON after being OFF.

The power-on initial setting is "RQS ON".

RISETIME**RQS (REQUEST FOR SERVICE)**

SEND

Type:

Output

Syntax:

SEND

Output Examples:

45.13755019E+6; (Frequency)
 3.0018E-6; (Period)
 01; (Probecomp)
 395; (Test)
 1977249.; (Totalize)

Discussion:

The SEND command formats available data for output. Data is available when a completed measurement result has not previously been output. If no data is available the SEND command causes the DC 5010 to wait for the current measurement to complete and then formats the result.

SETTINGS

Type:

Query

Syntax:

SET?
 SETTINGS?

Response:

<function>;CHA A;ATT <num>;COU xx;SLO xx;
 TERM xx;LEV <num>;CHA B;ATT <num>;COU xx;
 SLO xx;TERM xx;LEV <num>;AVE <num>;OPC xx;
 OVER xx;PRE xx;FIL xx;NULL xx;DT xx; USER xx; RQS
 xx;

Example Response:

FREQ A;CHA A;ATT 1;COU DC;SLO POS;TERM HI;
 LEV 1.500;CHA B;ATT 5;COU AC;SLO NEG;TERM LO;
 LEV -5.000;AVE -1;OPC OFF;OVER ON;PRE OFF;
 FIL OFF;NULL OFF;DT OFF;USER OFF;RQS ON;

Discussion:

The SETTINGS query returns the current settings of the instrument.

The SETTINGS query response may then be used at a later time to reset the instrument back to those settings.

SEND

SETTINGS

SLOPE**Type:**

Setting or Query

Setting Syntax:SLO NEG
POS**Examples:**SLO POSITIVE
SLOPE POS
SLOPE NEGATIVE
SLO NEG**Query Syntax:**

SLO?

Query Response:SLO POS;
SLO NEG;**Discussion:**

The SLOPE command sets the input trigger for the selected channel to the specified slope. The valid arguments are:

NEG — Input will trigger on negative going edge.
POS — Input will trigger on positive going edge.

The power-on initial setting is SLO POS.

For information on selecting channels see discussion of the CHANNEL command.

START**Type:**

Operational

Syntax:

START

Discussion:

The START command starts a TMANUAL or TOTALIZE A, TOTALIZE A+B, TOTALIZE A-B, measurement. For EVENTS, FALL, FREQUENCY, PERIOD, RATIO, RISE, TIME, or WIDTH measurements, START restarts measurement if STOPped.

SLOPE**START**

STOP

Type:

Operational

Syntax:

STOP

Discussion:

The STOP command stops all measurements except TEST and PROBECOMP. The STOP command is ignored when TEST or PROBECOMP measurements are being made.

When FALL, FREQUENCY, PERIOD, RATIO, RISE, TIME, WIDTH, or EVENTS measurements are STOPped, the measurement in process is aborted.

When TMANUAL or TOTALIZE measurements are STOPped, the current result is retained and the measurement can be restarted from the point where stopped.

STOP

TERMINATION

Type:

Setting

Syntax:

TER HI
TER LO

Examples:

TER HI
TERM LOW
TERMINATION HIGH

Query Syntax:

TER?

Query Response:

TER HI;
TER LO

Discussion:

The TERMINATION command sets the input termination for the selected channel to the specified setting. Valid arguments are:

HI — Set input termination to 1 M Ω , 23 pF
LO — Set input termination to 50 Ω

When the Termination setting is LO (50 Ω) and an overly large input signal (greater than 2 volts at $\times 1$ attenuation) is detected, the instrument automatically switches the Termination from LO to HI.

If the Termination is automatically switched from LO to HI, SRQ is asserted and remains asserted until the status is read via a serial poll or until cleared by RQS OFF or device clear. Channel A "50 Ω protect" is indicated by a Status Byte of 102 or 118 and an ERROR query response of 602. Channel B "50 Ω protect" is indicated by a Status Byte of 102 or 118 and an ERROR query response of 603.

The power-on initial setting is TERM HI.

For information on selecting channels, see the discussion of the CHANNEL command.

TERMINATION

TEST**Type:**

Operational

Syntax:

TEST

Discussion:

The TEST command sets up the instrument to perform repetitive self tests. The tests performed are the ROM tests, Serial I/O Hardware Test, and the Counter Hardware Integrity Test.

The tests performed by the TEST command are the same as those tests performed during the power-on self test sequence, with the exception of the instrument RAM tests. The RAM tests are only performed during power-on.

If a failure is detected by any of the tests, the test sequence is halted. The sequence is restarted when the instrument executes another TEST command or a RESET command.

The results of each TEST sequence are made available to be output by the instrument. A result of 0 indicates that no failures were detected. If a failure is detected, the value generated for output is the same as the error code that is displayed for power-on self test failures.

See section on "Error and Status Reporting".

TEST**TIME (TIME A TO B)****Type:**

Operational

Syntax:

TIME AB (argument is optional)

Examples:

TIME
TIME AB

Discussion:

The TIME command sets up the DC 5010 to measure the time interval from the first occurrence of an event on Channel A to the occurrence of the first succeeding event on Channel B.

TIME (TIME A TO B)

TMANUAL (TIME MANUAL)

Type:

Operational

Syntax:

TMAN
TMANUAL

Discussion:

The TMANUAL command sets up the DC 5010 to measure time in a "stop watch" type operation. Measurement is started by the "START" command and is halted by the "STOP" command. If in "DT GATE" mode, TMANUAL operation is started and stopped alternately using the Group Execute Trigger <GET> interface message.

See discussions of START, STOP, and DT commands.

See discussion of <GET> in Sending IEEE Interface Control Messages in this section.

TMANUAL (TIME MANUAL)

TOTALIZE

Type:

Operational

Syntax:

TOT A (argument is optional)
A+B
A-B

Examples:

TOTALIZE A+B
TOT A-B
TOT A

Discussion:

This command sets up the DC 5010 to measure and calculate the total number of events on the specified channel or channels. The measurement is started by the "START" command and stopped by the "STOP" command. If in "DT GATE" mode, TOTALIZE operation is started and stopped alternately using the Group Execute Trigger <GET> interface message.

In the A+B and A-B modes, the DC 5010 will only count B events after the first valid A event.

If no argument is specified, TOT A is assumed.

See discussions of START, STOP, and DT commands.

See discussion of <GET> in sending in IEEE Interface Control Messages in this section.

TOTALIZE

USEREQ (USER REQUEST)**Type:**

Setting or Query

Setting Syntax:

USER ON
 OFF

Examples:

USER ON
USEREQ OFF

Query Syntax:

USER?

Query Response:

USER ON;
USER OFF;

Discussion:

The USEREQ command controls the asserting of SRQ when the front panel INST ID button is pushed. This provides a communication capability between the instrument and a controller that can be initiated from the front panel of the instrument.

When USER is ON and the INST ID button is pushed, SRQ is asserted and remains asserted until the status is read via a serial poll or until cleared by RQS OFF or a Device Clear. The User Request is indicated by a Status Byte of 67 or 83 and an ERROR query response of ERR 403.

The power-on initial setting is USER OFF.

USEREQ (USER REQUEST)**WIDTH****Type:**

Operational

Syntax:

WID A (argument is optional)

Examples:

WIDTH A
WID

Discussion:

This command sets up the DC 5010 to measure the pulse width of the input signal on Channel A. The slope setting of Channel A determines whether positive going pulse width or negative-going pulse width is measured.

WIDTH

MESSAGES AND COMMUNICATION PROTOCOL

Command Separator

A message consists of one command or a series of commands, followed by a message terminator. Messages consisting of multiple commands must have the commands separated by semicolons. A semicolon at the end of a message is optional. For example, each line below is a message.

```
INIT
TEST;INIT;RQS ON;USER OFF;ID?;SET?
TEST;
```

Message Terminator

Messages may be terminated with EOI or the ASCII line feed (LF) character. Some controllers assert EOI concurrently with the last data byte; others use only the LF character as a terminator. The instrument can be internally set to accept either terminator. With EOI ONLY selected as the terminator, the instrument interprets a data byte received with EOI asserted as the end of the input message; it also asserts EOI concurrently with the last byte of the output message. With the LF/EOI setting, the instrument interprets the LF character without EOI asserted (or any data byte received with EOI asserted) as the end of an input message; it transmits carriage return (CR) followed by line feed (the LF with EOI asserted) to terminate output messages. Refer service personnel to the Maintenance section of the manual for information on setting the message terminator. TM 5000 instruments are shipped with EOI ONLY selected.

Formatting A Message

Commands sent to TM 5000 instruments must have the proper format (syntax) to be understood; however, this format is flexible and many variations are acceptable. The following describes this format and the acceptable variations.

The instruments expect all commands to be encoded in ASCII; however, they accept both upper and lower case ASCII characters. All data output is in upper case (see Fig. 2-11).

As previously discussed, a command consists of a header followed, if necessary, by arguments. A command with arguments must have a header delimiter which is the space character SP between the header and the argument.

RQS_{SP}ON

If extra formatting characters SP, CR, and LF (the LF cannot be used for format in the LF/EOI terminator mode) are added between the header delimiter and the argument, they are ignored by the instrument. (SP) (CR) and (LF) are shown as subscripts in the following examples:

Example 1: RQS_{SP}ON;

Example 2: RQS_{SP SP}ON;

Example 3: RQS_{SP CR LF SP SP}ON

In the command list, some headers and arguments are listed in two forms, a full-length version and an abbreviated version. The instrument accepts any header or argument containing at least the characters listed in the short form; any characters added to the abbreviated version must be those given in the full-length version. For documentation of programs, the user may add alpha characters to the full-length version. Alpha characters may also be added to a query header, provided the question mark is at the end.

```
USER?
USERE?
USEREQ?
USEREQUEST?
```

Multiple arguments are separated by a comma; however, the instrument will also accept a space or spaces as a delimiter.

2,3

2_{SP}3

2,_{SP}3

NOTE

In the last example, the space is treated as a format character because it follows the comma (the argument delimiter).

Number Formats

The instrument accepts the following kinds of numbers for any of the numeric arguments.

- Signed or unsigned integers (including +0 and -0). Unsigned integers are interpreted as positive. Examples: +1, 2, -1, -10
- Signed or unsigned decimal numbers. Unsigned decimal numbers are interpreted to be positive. Examples: -3.2, +5.0, 1.2
- Floating point numbers expressed in scientific notation. Examples: +1.0E-2, 1.0E-2, 0.01E+0

ASCII & IEEE 488 (GPIB) CODE CHART																			
BITS				0 0		0 0 1		0 1 0		0 1 1		1 0 0		1 0 1		1 1 0		1 1 1	
B4 B3 B2 B1				CONTROL				NUMBERS SYMBOLS				UPPER CASE				LOWER			
0 0 0 0				0 NUL	20 DLE	40 SP	60 0	100 @	120 P	140 \	160 p								
0 0 0 1				0 (0)	10 (16)	20 (32)	30 (48)	40 (64)	50 (80)	60 (96)	70 (112)								
0 0 0 1				1 SOH	21 DC1	41 !	61 1	101 A	121 Q	141 a	161 q								
0 0 0 1				1 (1)	11 (17)	21 (33)	31 (49)	41 (65)	51 (81)	61 (97)	71 (113)								
0 0 1 0				2 STX	22 DC2	42 "	62 2	102 B	122 R	142 b	162 r								
0 0 1 0				2 (2)	12 (18)	22 (34)	32 (50)	42 (66)	52 (82)	62 (98)	72 (114)								
0 0 1 1				3 ETX	23 DC3	43 #	63 3	103 C	123 S	143 c	163 s								
0 0 1 1				3 (3)	13 (19)	23 (35)	33 (51)	43 (67)	53 (83)	63 (99)	73 (115)								
0 1 0 0				4 EOT	24 DC4	44 \$	64 4	104 D	124 T	144 d	164 t								
0 1 0 0				4 (4)	14 (20)	24 (36)	34 (52)	44 (68)	54 (84)	64 (100)	74 (116)								
0 1 0 1				5 ENQ	25 NAK	45 %	65 5	105 E	125 U	145 e	165 u								
0 1 0 1				5 (5)	15 (21)	25 (37)	35 (53)	45 (69)	55 (85)	65 (101)	75 (117)								
0 1 1 0				6 ACK	26 SYN	46 &	66 6	106 F	126 V	146 f	166 v								
0 1 1 0				6 (6)	16 (22)	26 (38)	36 (54)	46 (70)	56 (86)	66 (102)	76 (118)								
0 1 1 1				7 BEL	27 ETB	47 '	67 7	107 G	127 W	147 g	167 w								
0 1 1 1				7 (7)	17 (23)	27 (39)	37 (55)	47 (71)	57 (87)	67 (103)	77 (119)								
1 0 0 0				8 BS	28 CAN	48 (68 8	108 H	128 X	148 h	168 x								
1 0 0 0				8 (8)	18 (24)	28 (40)	38 (56)	48 (72)	58 (88)	68 (104)	78 (120)								
1 0 0 1				9 HT	29 EM	49)	69 9	109 I	129 Y	149 i	169 y								
1 0 0 1				9 (9)	19 (25)	29 (41)	39 (57)	49 (73)	59 (89)	69 (105)	79 (121)								
1 0 1 0				10 LF	30 SUB	50 *	70 :	110 J	130 Z	150 j	170 z								
1 0 1 0				10 (10)	1A (26)	2A (42)	3A (58)	4A (74)	5A (90)	6A (106)	7A (122)								
1 0 1 1				11 VT	31 ESC	51 +	71 ;	111 K	131 [151 k	171 {								
1 0 1 1				11 (11)	1B (27)	2B (43)	3B (59)	4B (75)	5B (91)	6B (107)	7B (123)								
1 1 0 0				12 FF	32 FS	52 ,	72 <	112 L	132 \	152 l	172								
1 1 0 0				12 (12)	1C (28)	2C (44)	3C (60)	4C (76)	5C (92)	6C (108)	7C (124)								
1 1 0 1				13 CR	33 GS	53 -	73 =	113 M	133]	153 m	173 }								
1 1 0 1				13 (13)	1D (29)	2D (45)	3D (61)	4D (77)	5D (93)	6D (109)	7D (125)								
1 1 1 0				14 SO	36 RS	56 .	76 >	116 N	136 ^	156 n	176 ~								
1 1 1 0				14 (14)	1E (30)	2E (46)	3E (62)	4E (78)	5E (94)	6E (110)	7E (126)								
1 1 1 1				15 SI	37 US	57 /	77 ? UNL	117 O	137 _	157 o	177 RUBOUT (DEL)								
1 1 1 1				15 (15)	1F (31)	2F (47)	3F (63)	4F (79)	5F (95)	6F (111)	7F (127)								
ADDRESSSED COMMANDS				UNIVERSAL COMMANDS				LISTEN ADDRESSES				TALK ADDRESSES				SECONDARY ADDRESSES OR COMMANDS			
KEY TO CHART																			
octal	25	PPU	GPIB code																
NAK				ASCII character															
hex	15	(21)	decimal																

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Fig. 2-11. ASCII and IEEE 488 (GPIB) code chart.

Rounding of Numeric Arguments

The instrument rounds numeric arguments to the nearest unit of resolution and then checks for out-of-range conditions.

Message Protocol

As the instrument receives a message it is stored in the Input Buffer, processed, and executed. Processing a message consists of decoding commands, detecting delimiters, and checking syntax. For *setting commands*, the instrument then stores the indicated changes in the Pending Settings Buffer. If an error is detected during processing the instrument asserts SRQ, ignores the remainder of the message, and resets the Pending Settings Buffer. Resetting the Pending Settings Buffer avoids undesirable states which could occur if some *Setting Commands* are executed while others in the same message are not.

Executing a message consists of performing the actions specified by its command(s). For *setting commands*, this involves updating the instrument settings and recording these updates in the Current Settings Buffer. The *setting commands* are executed in groups—that is, a series of *setting commands* is processed and recorded in the Pending Settings Buffer before execution takes place. This allows the user to specify a new instrument state without having to consider whether a particular sequence would be valid. Execution of the settings occurs when the instrument processes the message terminator, a *query-output command*, or an *operational command* in a message.

When the instrument processes a *query-output command* in a message, it executes any preceding *setting commands* to update the state of the instrument. It then executes the *query-output command* by retrieving the appropriate data and putting it in the Output Buffer. Then, processing and execution continue for the remainder of the message. The data are sent to the controller when the instrument is made a talker.

When the instrument processes an *operational command* in a message, it executes any preceding *setting commands* before executing the *operational command*.

Multiple Messages

The Input Buffer has finite capacity and a single message may be long enough to fill it. In this case, a portion of the message is processed before the instrument accepts additional input. During command processing the instrument holds off additional data (by asserting NRFD) until space is available in the buffer.

When space is available, the instrument can accept a second message before the first has been processed. However, it holds off additional messages with NRFD until it completes processing the first.

After the instrument executes a *query-output command* in a message, it holds the response in its Output Buffer until the controller makes the instrument a talker. If the instrument receives a new message before all of the output from the previous message is read it clears the Output Buffer before executing the new message. This prevents the controller from getting unwanted data from old messages.

One other situation may cause the instrument to delete output. The execution of a long message might cause both the Input and Output buffers to become full. When this occurs, the instrument cannot finish executing the message because it is waiting for the controller to read the data it has generated; but the controller cannot read the data because it is waiting to finish sending its message. Because the instrument's Input buffer is full and it is holding off the rest of the controller's message with NRFD, the system is hung up with the controller and instrument waiting for each other. When the instrument detects this condition, it generates an error, asserts SRQ and deletes the data in the Output buffer. This action allows the controller to transmit the rest of the message and informs the controller that the message was executed and that the output was deleted.

A TM 5000 instrument can be made a talker without having received a message which specifies what it should output. In this case, acquisition instruments (counters and digital multimeters) return a measurement if one is ready. If no measurement is ready, they return a single byte message with all bits equal to 1 (with message terminator); other TM 5000 instruments will return only this message.

Instrument Response to IEEE-488 Interface Messages

Interface messages and their effects on the instrument's interface functions are defined in IEEE Standard 488-1978. Abbreviations from the standard are used in this discussion which describes the effects of interface messages on instrument operation.

UNL—Unlisten UNT—Untalk

When the UNL command is received, the instrument's listener function goes to its idle state (unaddressed). In the idle state, the instrument will not accept instrument commands from the GPIB.

The talker function goes to its idle state when the instrument receives the UNT command. In this state, the instrument cannot output data via the GPIB.

The ADDRESSED light is off when both the talker and listener functions are idle. If the instrument is either talk addressed or listen addressed, the light is on.

IFC—Interface Clear

This uniline message has the same effect as both the UNT and UNL messages. The front panel ADDRESS light is off.

DCL—Device Clear

The Device Clear message reinitializes communication between the instrument and controller. In response to DCL, the instrument clears any input and output messages and any unexecuted settings in the Pending Settings Buffer. Also cleared are any errors or events waiting to be reported, except the power-on event. If the SRQ line is asserted for any reason other than power-on, when DCL is received the SRQ is unasserted.

SDC—Selected Device Clear

This message performs the same function as DCL; however, only instruments that are listen addressed respond to SDC.

GET—Group Execute Trigger

The instrument responds to GET only if it is listen addressed and the instrument device trigger function has been enabled by the Device Trigger command (DT). The GET message is ignored and an SRQ generated if the DT function is disabled (DT OFF), the instrument is in the local state, or if a message is being processed when GET is received.

SPE—Serial Poll Enable

SPD—Serial Poll Disable

The SPE message enables the instrument to output serial poll status bytes when it is talk addressed. The SPD message switches the instrument back to its normal operation of sending the data from the Output buffer.

MLA—My Listen Address

MTA—My Talk Address

The primary listen and talk addresses are established by the instruments GPIB address (internally set). The current setting of the GPIB address is displayed on the front panel when the INST ID button is pressed.

LLO—Local Lockout

In response to LLO, the instrument goes to a lockout state—from LOCS to LWLS or from REMS to RWLS.

REN—Remote Enable

If REN is true, the instrument goes to a remote state (from LOCS to REMS or from LWLS to RWLS) when its listen address is received. REN false causes a transition from any state to LOCS; the instrument stays in LOCS as long as REN is false.

A REN transition may occur after message processing has begun. In this case execution of the message being processed is not affected by a transition.

GTL—Go To Local

Only instruments that are listen addressed respond to GTL by going to a local state. Remote-to-local transitions caused by GTL do not affect the execution of the message being processed when GTL was received.

Remote-Local Operation

The preceding discussion of interface messages describes the state transitions caused by GTL and REN. Most front panel controls cause a transition from REMS to LOCS by asserting a message called return-to-local (*rtl*). This transition may occur during message execution; but in contrast to GTL and REN transitions, a transition initiated by *rtl* does affect message execution. In this case, the instrument generates an error if there are any unexecuted setting or operational commands. Front panel controls that only change the display (like ID) do not affect the remote-local states—only front panel controls that change settings assert *rtl*. *Rtl* is unasserted after processing the front panel control change.

Local State (LOCS)

In LOCS, instrument settings are controlled by the operator via front panel controls. When in LOCS, only bus commands that do not change instrument settings are executed (*query-output commands*); all other bus commands (*setting and operational*) generate an error since their functions are under front panel control.

Local With Lockout State (LWLS)

The instrument operates the same as it does in LOCS, except that *rtl* will not inhibit a transition to RWLS.

Remote With Lockout State (RWLS)

The instrument operation is identical to REMS operation except that the *rt/* message is ignored.

Remote State (REMS)

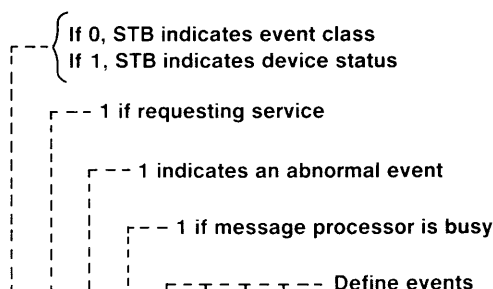
In this state, the instrument executes all instrument commands. Changing a front panel control, except trigger level controls, generates an *rt/* and causes the instrument to return to local (LOCS).

STATUS AND ERROR REPORTING

Through the Service Request function (defined in the IEEE-488 Standard), the instrument may alert the controller that it needs service. This service request is also a means of indicating that an event (a change in status or an error) has occurred. To service a request the controller performs a Serial Poll; in response the instrument returns a Status Byte (STB) which indicates whether it was requesting service or not. The STB can also provide a limited amount of information about the request. The format of the information encoded in the STB is given in Table 2-2. When data bit 8 is set, the STB conveys Device Status information which is indicated by bits 1 through 4.

Table 2-2
DEFINITION OF STATUS BYTE BITS

Status Byte (Example)	DATA BITS								DECIMAL	
	8	7	6	5	4	3	2	1	Not Busy	Busy
Power On	0	1	0	X	0	0	0	1	65	81
Channel A overflow	1	1	0	0	0	0	0	1	193	209
Channel B overflow	1	1	0	0	0	0	1	0	194	210



Because the STB conveys limited information about an event, the events are divided into classes; the Status Byte reports the class. The classes of events are defined as follows:

COMMAND ERROR	Indicates the instrument has received a command which it cannot understand.
EXECUTION ERROR	Indicates that the instrument has received a command that it cannot execute. This is caused by arguments out of range or settings that conflict.
INTERNAL ERROR	Indicates that the instrument has detected a hardware condition or firmware problem that prevents operation.
SYSTEM EVENTS	Events that are common to instruments in a system (e.g., power-on, User Request, etc.).
EXECUTION WARNING	The instrument is operating but the user should be aware of potential problems.
INTERNAL WARNING	Internal warning indicates that the instrument has detected a problem. The instrument remains operational, but the problem should be corrected (e.g., out of calibration).
DEVICE STATUS	Device dependent events.

The instrument can provide additional information about many of the events, particularly the errors reported in the Status Byte. After determining that the instrument requested service (by examining the STB) the controller may request the additional information by sending an error query (ERR?). In response, the instrument returns a code which defines the event. These codes are described in Table 2-3.

If there is more than one event to be reported, the instrument continues to assert SRQ until it reports all events. Each event is automatically cleared when it is reported via Serial Poll. The Device Clear (DCL) interface message may be used to clear all events except power-on.

Commands are provided to control the reporting of some individual events and to disable all service requests. For example, the User Request command (USEREQ) provides individual control over the reporting of the user request event which occurs when the front panel INST ID button is pressed. The Requests for Service command (RQS) controls whether the instrument reports any events with SRQ.

Table 2-3
BUS ERROR CODES AND
SERIAL POLL RESPONSE

Description	Error Query Response	Serial Poll ^a (Decimal)
Command Errors		
Command header error	101	97
Header delimiter error	102	97
Command argument error	103	97
Argument delimiter error	104	97
Nonnumeric argument (numeric expected)	105	97
Missing argument	106	97
Invalid message unit delimiter	107	97
Execution Errors		
Command not executable in Local	201	98
Settings lost due to "rti"	202	98
I/O buffers full, output dumped	203	98
Argument out of range	205	98
Group execute trigger ignored	206	98
Internal Errors		
Interrupt fault	301	99
System error	302	99
System Events		
Power on ^b	401	65
Operation Complete	402	66
User request	403	67
Device Warnings		
Channel A 50 Ω protect	602	102
Channel B 50 Ω protect	603	102
No prescaler	604	102
Device Dependent Events		
Channel A overflow	711	193
Channel B overflow	712	194
No Errors or Events	0	0
Data not ready	0	128
Data ready	0	132

^aIf the instrument is busy, it returns a number which is 16 higher than the number shown.

^bSee Table 2-2 for example.

RQS OFF inhibits all SRQ's (except power-on event) so in this mode the ERR? query allows the controller to find out about events without first performing a Serial Poll. With RQS OFF, the controller may send the ERR? query at any time and the instrument returns an event waiting to be reported (see Table 2-4). The controller can clear all events by sending the error query until a zero (0) code is returned, or clear all events except power-on through the DCL interface message.

With RQS OFF the controller may perform a Serial Poll, but the Status Byte only contains Device Dependent Status information. With RQS ON, the STB contains the class of the event and a subsequent error query returns additional information about the previous event reported in the STB.

Table 2-4
FRONT PANEL DISPLAY ERROR CODES

Serial I/O Fault	313
Channel A	
Counter Integrity	320-324, 329
Channel B	
Counter Integrity	330-334, 339
System RAM Error U1410	340
System RAM Error U1610	341
System RAM Error U1311	342
ROM placement error U1610	361
ROM placement error U1102	374
ROM placement error U1201	375
ROM checksum error U1410	380
ROM checksum error U1610	381
ROM checksum error U1102	394
ROM checksum error U1201	395

SENDING INTERFACE CONTROL MESSAGES

Bus communications are performed through use of the controller input and output statements. ASCII commands are transmitted using the PRINT statements. The DC 5010 is factory set to address 20.

```
PRINT @ 20:"SET?;"
```

ASCII replies are received by the controller using input statements.

```
INPUT @ 20:A$
```

Bus interface control messages are sent as low level commands through the use of WBYTE controller commands. For the following commands A = 32 plus the instrument address and B = 64 plus the instrument address.

Listen	WBYTE @ A:
Unlisten	WBYTE @ 63:
Talk	WBYTE @ B:
Untalk	WBYTE @ 95:
Unlisten-untalk	WBYTE @ 63, 95:
Device clear (DCL)	WBYTE @ 20:
Selective device clear (SDC)	WBYTE @ A, 4:
Go to local (GTL)	WBYTE @ A, 1:
Remote with lockout	WBYTE @ A, 17, 63:
Local lockout of instruments	WBYTE @ 17:
Group execute trigger (GET)	WBYTE @ A, 8:

These commands are for the TEKTRONIX 4050-Series controllers and representative for other controllers.

A programming guide for Tektronix controllers, such as the 4052 Graphic Computing System; is available. This guide contains programming instructions, tips, and example programs for use with this instrument. Ask your Tektronix Sales Engineer for a copy or order the GPIB Programming Guide, Tektronix Part No. 070-3985-00.

POWER ON SETTINGS

At power-on the instrument's settings are initialized as indicated in Table 2-5.

In addition, an autotrigger is performed to set the trigger levels and to set the maximum and minimum peak values.

Table 2-5
POWER ON SETTINGS

Header	Argument
FREQ	A
AVG —1	AUTO
SLO (CHA & B)	POS
ATT (CHA A & B)	X1
COU (CHA A & B)	DC
TER (CHA A & B)	HI
FIL	OFF
PRE	OFF
CHA	A
OPC	OFF
OVER	OFF
DT	OFF
USER	OFF
RQS	ON

EXAMPLE PROGRAMS

TALKER LISTENER PROGRAMS

These sample programs allow a user to send any of the commands listed in the Functional Command List and to receive the data generated.

Talker Listener Program For 4050-Series Controllers

```
100 REM DC5010 TALKER/LISTENER PROGRAM
110 REM DC5010 PRIMARY ADDRESS = 20
120 INIT
130 ON SRQ THEN 260
140 DIM A$(200)
150 PRINT "ENTER MESSAGE(S): ";
160 INPUT C$
170 PRINT @20:C$
180 REM CHECK FOR QUERIES
190 IF POS(C$,"?",1)<>0 THEN 220
200 REM CHECK FOR 'SEND'
210 IF POS(C$,"SEND",1)=0 THEN 150
220 REM INPUT FROM DEVICE
230 INPUT @20:A$
240 PRINT A$
250 GO TO 150
260 REM SERIAL POLL ROUTINE
270 POLL X,Y;20
280 PRINT "STATUS BYTE: ";Y
290 RETURN
```

Talker Listener Program For 4040-Series Controllers

```
100 Rem DC5010 TALKER/LISTENER PROGRAM
110 Rem      PRIMARY ADDRESS = 20
120 Init all
130 On srq then gosub srqhdl
140 Enable srq
150 Dim respons$ to 200
160 Input prompt "ENTER MESSAGE(S): ":message$
170 Print #20:message$
180 Rem CHECK FOR QUERIES
190 If pos(message$,"?",1) then goto 260
200 Rem CHECK FOR 'SEND' COMMAND
210 If pos(message$,"SEND",1) then goto 260
220 Rem CHECK FOR 'TEST' COMMAND
230 If pos(message$,"TEST",1) then goto 260
240 Goto 160
250 Rem INPUT FROM DEVICE
260 Input #20:respons$
270 Print "RESPONSE: ";respons$
280 Goto 160
290 Rem SERIAL POLL ROUTINE
300 Srqhdl: poll stb,pri
310 Print "STATUS BYTE: ";stb
320 Resume
330 End
```


PROGRAMMING HINTS

The purpose of this section of the manual is to show how to program the DC 5010 to perform some basic measurement functions and how to take advantage of some of its special programming features.

The following examples are given in 4050-Series BASIC. The implementation details vary from controller to controller.

Changing Input Channel Settings

Before a meaningful measurement can be made, the input signal conditioning settings must be set properly. The following example first sets up the Channel A input signal conditioning. Next the trigger levels are automatically set to their midpoints using the AUTO command and the AVE -1 command sets up the instrument to make measurements at a rate of approximately 3 per second. Finally, the DC 5010 is instructed to make frequency measurements.

```
100 PRINT @20:"CHA A:SLO POS;TERM HI;"
110 PRINT @20:"COU DC;ATT 1:AUTO;"
120 PRINT @20:"AVE -1:FREQ;SEND;"
130 INPUT @20:R
140 PRINT "THE FREQUENCY IS ";R
150 END
```

Although the above example shows all the Channel A input settings being programmed to the desired states, only those settings not already at the desired states need to be programmed.

Making Time Interval Measurement

The following example sets up the instrument to measure the time interval between two TTL level signals connected to the Channel A and Channel B inputs using $\times 5$ probes.

```
200 PRINT @20:"CHA A:SLO POS;TERM HI;"
210 PRINT @20:"ATT 1;COU DC;LEV 0.275;"
220 PRINT @20:"CHB B:SLO POS;TERM HI;"
230 PRINT @20:"ATT 1 COU DC;LEV 0.275;"
240 PRINT @20:"AVE 1;TIME;SEND;"
250 INPUT @20:T
260 PRINT "TIME A TO B IS ";T
270 END
```

Again, only those input channel settings not already at the desired states would have to be programmed.

Making Single Measurements

Single measurements may be made using either of the two methods shown in the following examples. To make a single measurement, the instrument is first set to STOP mode. A RESET then causes a single measurement to be made and then the measurement process is again stopped. The first example shows how to make a single TIME interval measurement using STOP and RESET.

```
300 PRINT @20:"AVE 1;TIME;"
310 PRINT @20:"STOP;RESET;SEND;"
320 INPUT @20:R
330 PRINT "TIME INTERVAL IS ";R
340 END
```

The next example shows how to use Group Execute Trigger <GET> in place of the RESET, to make single measurements. To use <GET>, the instrument's Device Trigger Function must first be enabled using the DT TRIG command. Again, the instrument must be set to STOP mode before the <GET> causes a RESET and a single measurement to be made.

```
400 PRINT @20:"DT TRIG;AVE 1;TIME;"
410 PRINT @20:"STOP;"
420 FOR I=1 TO 200
430 REM ALLOW TIME FOR COUNTER TO
440 REM PROCESS PENDING SETTINGS
450 REM BUFFER
460 NEXT I
470 REM 52 IS LISTEN ADDR. 20 (32+20)
480 REM 8 IS <G.E.T.> IEEE-488
490 WBYTE @52,8:
500 PRINT @20:"SEND;"
510 INPUT @20:R
520 PRINT "TIME INTERVAL IS ";R
530 END
```

Reading Results

There are two basic ways of obtaining measurement data from the DC 5010. The first method shown below uses the SEND command to request a measurement result from the instrument. If a measurement result is available, the DC 5010 will respond immediately when "talked", otherwise it will wait until a result is available before responding.

```
300 PRINT @20:"FREQ;"
310 PRINT @20:"SEND;"
320 INPUT @20:A
330 PRINT "FREQUENCY IS ";A
340 END
```

The other method that may be used to obtain measurement data involves just "talking" the DC 5010 and then reading the results. If a result is available, "talking" the instrument causes the result to be output. If a result is not available, it causes the instrument to output an FF(hex) byte instead. The following example shows how to read out data by just "talking" the instrument and checking for FF(hex).

```
200 PRINT @20:"FREQ;";
210 INPUT @20:A$
220 IF LEN(A$)=0 THEN 210
230 PRINT "FREQUENCY IS ";A
240 END
```

Both the RDY? and OPC commands can be used to determine when measurement data is available to be read out. Data ready status can be queried using the RDY? query command, as in the following example.

```
100 PRINT @20:"PER;";
110 PRINT @20:"RDY?;";
120 INPUT @20:R
130 IF R=0 THEN 110
140 INPUT @20:A
150 PRINT "PERIOD IS ";A
160 END
```

The following example shows how the OPC command allows the Service Request (SRQ) and the Status Byte response (STB) to be used to signal data ready.

```
100 REM USING OPC INTERRUPT AND
110 REM STATUS BYTE TO SIGNAL
120 REM WHEN THE DATA IS READY
130 A=0
140 PRINT @20:"PER;OPC ON;";
150 ON SRQ THEN 220
160 WAIT
170 IF A=0 THEN 160
180 PRINT @20:"SEND;OPC OFF;";
190 INPUT @20:A
200 PRINT "PERIOD IS ";A
210 END
220 POLL D,S;20
230 IF S=66 OR S=82 THEN 260
240 PRINT "SRQ OCCURED, STATUS = ";S
250 GO TO 270
260 A=1
270 RETURN
```

Extending Range Using Overflow

Overflow occurs when the internal 43-bit capacity of the counter is exceeded. By detecting these occurrences of Overflow, the range of Tmanual and Totalize measurements may be extended.

The following example monitors a Totalize measurement watching for the count to reach $1.0E+14$, approximately 11 times the counting capacity of the DC 5010. This is done by counting occurrences of Overflow and using this count to extend the precision of the result.

```
1 REM<EXTENDING RANGE USING>
2 REM OVERFLOW - TOTALIZE A
100 C=0
110 PRINT @20:"OVER ON;TOT;START;";
120 ON SRQ THEN 500
130 PRINT @20:"SEND;";
140 INPUT @20:A
150 R=A+C*8.796093022E+12
160 IF R<1.0E+14 THEN 130
170 PRINT "RESULT IS ";R
180 PRINT @20:"OVER OFF;";
190 END
500 POLL D,S;20
510 IF S=193 OR S=209 THEN 540
520 PRINT "SRQ OCCURED, STATUS = ";S
530 RETURN
540 C=C+1
550 RETURN
```

The next example monitors a Tmanual measurement to determine when 24 hours have elapsed. Since 24 hours is equivalent to 86,400 seconds, it exceeds the 27487.8 seconds counting capacity of the DC 5010. By counting the occurrences of Overflow, the precision can be extended to count this amount of time.

```
1 REM<EXTENDING RANGE USING>
2 REM OVERFLOW - TIME MANUAL
100 C=0
110 PRINT @20:"OVER ON;";
120 PRINT @20:"TMAN;START;";
130 ON SRQ THEN 210
140 PRINT @20:"SEND;";
150 INPUT @20:A
160 R=A+C*27487.79069
170 IF R<86400 THEN 140
180 PRINT "RESULT IS ";R
190 PRINT @20:"OVER OFF;";
200 END
210 POLL D,S;20
220 IF S=194 OR S=210 THEN 250
230 PRINT "SRQ OCCURED, STATUS = ";S
240 RETURN
250 C=C+1
260 RETURN
```

Using INST ID Button

Communication between the controller and an instrument operator can be accomplished using the INST ID button and the USER command. The following example allows a front panel operator to compensate probes and then inform the controller that the Probecomp is complete. As shown, the probes can be compensated and the INST ID button used even while the rest of the front panel controls are locked out.

```

1 REM {USING THE INST ID BUTTON}
100 PRINT "COMPENSATE PROBES - ";
110 PRINT "PUSH INST ID BUTTON ";
120 PRINT "WHEN DONE."
130 I=0
140 PRINT @20:"USER ON;PROBE;"
150 REM GPIB "LLO" IS 17
160 WBYTE @17:
170 ON SRQ THEN 300
180 WAIT
190 IF I=0 THEN 180
200 PRINT @20:"INIT;"
210 PRINT "COMPENSATION DONE."
220 END
300 POLL D,S;20
310 IF S=67 OR S=93 THEN 340
320 PRINT "SRQ OCCURED, STATUS = ";S
330 GO TO 360
340 PRINT "INST ID BUTTON SENSED."
350 I=1
360 RETURN

```

The INST ID button can also be used to inform the controller that the instrument has been set up properly to measure the input signals. Once informed, the controller can then "learn" the current instrument settings, using the SET? query command, and save the setup for later use.

```

800 REM LEARN SETTINGS
810 PRINT "SET UP THE INSTRUMENT - ";
820 PRINT "PUSH INST ID WHEN DONE."
830 DIM A$(215)
840 I=0
850 PRINT @20:"USER ON;"
860 ON SRQ THEN 940
870 WAIT
880 IF I=0 THEN 870
890 PRINT @20:"SET?;"
900 INPUT @20:A$
910 PRINT "STORED SETTINGS ARE: ";A$
920 PRINT @20:"USER OFF;"
930 END
940 POLL D,S;20
950 IF S=67 OR S=93 THEN 980
960 PRINT "SRQ OCCURED, STATUS = ";S
970 GO TO 990
980 I=1
990 RETURN

```

Duty Cycle Measurement

Duty Cycle measurements can easily be made using a combination of Width and Period measurements. The following example determines the Duty Cycle of the positive going pulse of the Input signal. This example assumes the trigger level is already set to the desired value.

```

400 REM DUTY CYCLE MEASUREMENT
410 PRINT @20:"CHA A;SLO POS;"
420 PRINT @20:"WID;SEND;"
430 INPUT @20:W
440 PRINT @20:"PER;SEND;"
450 INPUT @20:P
460 D=W/P
470 PRINT "THE DUTY CYCLE IS ";D
480 END

```

Phase Measurement

A combination of Period and Time measurements can be used to make Phase measurements. The following example determines the phase difference between the Channel A and Channel B signals by first measuring the Period of one signal and then using the Time function to measure the time difference between the two signals. The phase angle is then computed using these two measurements. This example assumes that the appropriate signals are connected to input channels A and B and assumes that the trigger levels are set correctly.

```

1 REM {PHASE MEASUREMENT}
100 PRINT @20:"CHA A;SLO POS;"
110 PRINT @20:"CHA B;SLO POS;"
120 PRINT @20:"PER;SEND;"
130 INPUT @20:P
140 PRINT @20:"TIME;SEND;"
150 INPUT @20:T
160 F=T/P*360
170 PRINT "THE PHASE IS ";F
180 END

```

Slew Rate Measurements

Slew Rate measurements can be made using a combination of the RISE and MIN?; MAX? commands. The RISE command measures the risetime between the 10% and 90% points. The signal level difference between the 10% and 90% points is then calculated using the results returned for the MIN? and MAX? query commands. Using the signal level difference and risetime values, the slew rate is determined.

```
400 REM SLEW RATE
410 PRINT @20:"RISE;SEND;"
420 INPUT @20:R
430 PRINT @20:"CHA A;MIN?;MAX?;"
440 INPUT @20:A1,A2
450 D=(A2-A1)*0.8
460 S=D/R
470 PRINT "SLEW RATE IS ";S
480 END
```

Additional assistance in developing specific application oriented software is available in the following Tektronix manuals.

- 1 070-3985-00—GPIB Programming Guide. This manual is specifically written for applications of this instrument in IEEE-488 systems. It contains programming instructions, tips and some specific example programs.
- 2 070-2270-00—4051 GPIB Hardware Support Manual. This manual gives an indepth discussion of IEEE-488 bus operation, explanations of bus timing details and early bus interface circuitry.
- 3 070-2058-01—Programming In BASIC
- 4 070-2059-01—Graphic Programming In BASIC
- 5 062-5971-01—4050-Series Programming Aids, T1 (includes software)
062-5972-01—4050-Series Programming Aids, T2 (includes software)
- 6 070-2380-01—4907 File Manager Operators manual
- 7 070-2128-00—4924 Users manual
- 8 070-1940-01—4050 Series Graphic System Operators manual
- 9 070-2056-01—4050 Series Graphic System Reference manual
- 10 070-3918-00—4041 Operators manual
- 11 061-2546-00—4041 Programming Reference manual

THEORY OF OPERATION

BLOCK DIAGRAM DESCRIPTION

Introduction

Refer to the Block Diagram illustration located in the foldout pages at the rear of this manual during the following discussion.

Signal Conditioning and Amplifiers

The functional blocks for the Signal Conditioning and Amplifiers (Channel A and Channel B) are essentially identical. Each channel amplifier circuit contains seven magnetic latching relays, which control the input conditioning and routing of the front-panel input signals. Six relays control the ac or dc coupling modes, the 1 or 5 attenuation factors, and the termination impedance. The seventh relay provides for a Channel A and Channel B commoning function. The data for these relays are sent from the microprocessor via data shifted through serial-to-parallel shift registers, in these functional blocks.

The Channel A and Channel B amplifiers use matched DMOS FET followers that buffer the input signal and trigger level. The buffered signal and trigger level are combined and amplified in a differential cascode integrated circuit (IC). This IC also provides for switching the output into a low pass filter or straight through at full bandwidth.

Schmitt Triggers

The amplified signal and trigger level are applied to the inputs of the Schmitt trigger IC. The differential Schmitt output is applied to transistors that select the triggered slope. This circuit also provides the Shaped Out signals.

D/A's, Relay Protect, and Arming

This functional block contains triggering level control and 10-bit digital-to-analog converters (D/A converters) for Channel A and Channel B. The operational amplifiers driven from the D/A converter output, set both the offset and range for the individual channels.

The 50 Ω protect circuitry consists of two "window" comparators (Channel A and Channel B). These comparators receive the protect sense levels from the Channel A or Channel B inputs (relays) and operate within a ± 2 volts window sense level. If these voltage levels vary up or down from this window, the comparators will send a protection signal (50 Ω protect) to the microprocessor. The microprocessor automatically changes the input impedance to 1 M Ω and protects the 50 Ω circuitry.

The arming input is applied from the front panel or rear interface. This circuit consists of a 1 TTL input load with appropriate input protection and a Schmitt trigger circuit for noise immunity. The output provides the arming signal (ARM).

Main Gating

After the Schmitt trigger, the signals to be measured are routed through the proper logic gates for the operating mode selected. These gates are enabled (or disabled) via latched data in a serial-to-parallel shift register located in this functional block.

The counter has what is sometimes called a "ratio architecture". That is, events are always accumulated in one count chain, called Accumulator A, and a time related or Channel B event count is accumulated in another counter chain, called Accumulator B. The microprocessor actually controls the measurement interval, which is typically asynchronous with the input signals. Thus, two flip flop synchronizers are used to guarantee that the accumulators always see a whole number of pulses of input signals (Q1112) or a whole number of pulses (U1110C) from the internal time base that is being counted.

The arming input (ARM), from D/A's, RELAY PROTECT AND ARMING functional block, is applied to this block where it is logically ANDed with the measurement GATE generated by the microprocessor.

Time Base, 320 MHz PLL, and Noise Generator

This block contains the 10 MHz crystal controlled time base, a 320 MHz PLL (phase-locked loop) and a pseudo-random noise generator that is activated for time interval averaging measurements.

The 320 MHz PLL circuit contains a frequency and phase comparator, a filter circuit, a Varactor diode for 320 MHz tuning, and a feedback loop consisting of a fast divide-by-4 section followed by a divide-by-80 section.

CH A and CH B Count Chains

The Channel A signal is divided or counted by four ECL binary stages, five LS TTL binary stages, and then by four binary stages in a single CMOS counter. The CH A SLOW output from the CMOS counter is then applied to a microprocessor peripheral device on schematic 9, where the signal is counted by another 16 binary stages internal to that device.

The CH B Accumulator is similar to the CH A Accumulator with four ECL binary stages, five LS TTL binary stages, followed by 15 binary stages in two CMOS counters. The CH B SLOW signal is also applied to the microprocessor peripheral device on schematic 9. Each accumulator circuit has ECL to TTL or ECL to CMOS translator circuits where required.

The outputs of these counters are applied to the parallel inputs of five parallel-to-serial shift registers (two for CH A and three for CH B). To obtain the binary count accumulated in these counters, the microprocessor asserts the Serial Read Latch Line at least once for every measurement interval.

Processor and Display Drivers

The microprocessor located on the GPIB board controls the measurement gate interval, generates the relay strobe signal, and by using address decoding circuits enables the shift registers, display strobe circuits, and the data buffer for the front panel button sensing. This functional block has a microprocessor peripheral device containing a 128×8 static RAM, a 2048×8 ROM, a programmable counter, an 8-bit serial data channel, bidirectional data lines, and interrupt inputs. Additional program memory space is provided by a 4096×8 ROM and a 256×8 RAM.

Pushbuttons and LED's/Display

The key element in this functional block is a ten-state decade counter that provides the time slot decoding for scanning the front panel pushbuttons and other controls. The counter also provides the multiplexing functions for the seven-segment LED display and annunciators. Information is presented to the display by latching six bits of data from the microprocessor parallel data bus. Four bits of the latched data are then decoded from binary coded decimal to seven-segment information. The remaining two bits are used to drive the annunciators and decimal points.

The display consists of nine seven-segment LEDs, annunciators, and the LEDs of the lighted pushbuttons. The time slot lines generated by a ten-state decade counter drives the common cathodes of the seven-segment LEDs and scans the buttons and annunciators. The anodes of the seven-segment LEDs are connected to a buffer circuit through current limiting resistors.

Power Supplies

The instrument draws power from both of its power module connectors to derive its four primary supplies: +5V and +12 V on the Auxiliary board and another +5 V and a -12 V supply on the Digital board. Each supply is current limited and individually fused, and all four are referenced to a single precision 2.5 V reference IC. Several secondary supplies include +2.7 V for the ECL terminator, a +18 V three-terminal regulator chip (in option 01 timebase only), a -5 V supply derived from the -12 V, a 2.5 V supply to drive the reference IC, and several isolated versions of +5 V, separated by L-C filters.

GPIB Interface

The GPIB consists mainly of a microprocessor, two ROM's, one RAM, and a GPIB controller chip. An address switch is also available, which sets the listen and talk addresses for the DC 5010. In the DC 5010, the GPIB board connects to the digital board and is used to communicate with the IEEE-488 Digital Interface.

The microprocessor uses a serial data loop, an 8-bit parallel data bus, and a 16-bit address bus to communicate with the instrument functions. The microprocessor fetches instructions from memory via the parallel data path, decodes the desired operation, and executes the instruction. The activities of the microprocessor occur in cycles generated by its own 1 MHz system clock.

DETAILED CIRCUIT DESCRIPTION

SIGNAL CONDITIONING AND AMPLIFIERS—DIAGRAM 1

NOTE

Since the Channel B Signal Conditioning and Amplifier circuitry is essentially identical to the Channel A circuitry, this description discusses the theory of operation for the Channel A circuits only.

The Channel A input signal is routed to two magnetic latching relays. Relays K1612S (Channel A) and K1632S (Channel B) provide a normal mode operation (separate channels) or common mode operation (both channels). In the common mode operation (Common Separate), Channel B input becomes an open circuit. The common mode operation is used when making risetime and falltime measurements. In this mode, with the input impedance set to 50 Ω , the leadless chip component, R1611, in conjunction with the 50 Ω (TERM) in each channel, becomes an internal power splitter. Relays K1611S and K1510S provide for 50 Ω or 1 M Ω (TERM) input impedance selection. Resistor R1511 provides the 50 Ω termination. When in 50 Ω input impedance, relay K1610S selects either ac or dc coupling (COUPL). In the dc coupling position, resistor R1612 discharges the ac coupling capacitor, C1610. Component R1512 is the isolate resistor for the 50 Ω Protect A sense line, which will be discussed later. Relay K1511 selects either the X1 or X5 attenuation (ATTEN), when in 50 Ω (TERM).

In the 1 M Ω termination, selected by K1611S, relay K1600 selects either ac or dc coupling (COUPL). In the dc coupling position, resistor R1601 discharges the ac coupling capacitor, C1601. If X5 attenuation is selected, the signal enters the hybrid attenuator, AT1505. The component C1504 is a compensation capacitor and R1504 is the 1 M Ω termination resistor. When attenuated, resistors R1506 and R1507 provide damping for optimum ac performance.

Input signal protection is provided by diode network, CR1512, CR1510, CR1511, CR1513, and resistor R1510 and capacitor C1518.

A matched pair of DMOS field effect transistors (FET), Q1410, provide buffering for both the input signal (at pin 8) and the triggering level signal (at pin 4). These matched FET devices cause a matched level shift from 0 volts to approximately -4.5 volts. Diodes CR1411, VR1412 and CR1410, VR1413 will limit large (overdriving) signals and protect inte-

grated circuit (IC) U1311. In common mode operation, differential transformer, T1410 converts a single-ended signal into a differential signal at high frequencies. This helps to provide for better high frequency performance and helps to reject noise. The FET source followers each have a current source. Transistor Q1402 is the current source for the triggering level source follower output. Transistor Q1403 is the current source for the input signal source follower output.

The IC U1311 is a cascode differential amplifier with switched signal output capability. Signals can be either passed straight through at full bandwidth or through a two-pole low pass filter that passes frequencies from dc to approximately 20 MHz. These signals are switched by control voltages generated from the logic signal $\overline{\text{FILTER}}$ at pins 12 and 11 of U1311. Being complimentary, through Q1211 (signal inverter) and Q1210 (buffer) they appear in the Channel B circuitry as well. Therefore, the filters may or may not be selected by these inputs.

Resistor R1417 sets the gain for U1311 (pins 2 and 3). This leadless chip component is soldered directly to the IC pins for optimum ac performance. Transistors Q1400 and Q1401 are current sources for the cascode differential input. Low frequency peaking is provided by components R1406, R1405, and C1403.

SCHMITT TRIGGERS—DIAGRAM 2

The buffered and amplified differential signal is applied to pins 2 and 3 of U1310 (Schmitt Trigger circuit). These signals are looped through this IC and appear at pins 12 and 11, with the load resistors R1313 and R1216. Transistor Q1303 is a current source for the Schmitt Trigger latch devices. The Schmitt Trigger differential output (pins 6 and 8 of U1310) is level shifted by transistors Q1204, Q1302, Q1300, and Q1301. Positive slopes are selected by Q1204 and Q1302 and negative slopes are selected by Q1300 and Q1301. These common base stage level shifters are driven by the + SLOPE A and - SLOPE A signals through transistors Q1202, Q1201, and associated circuitry. The shaped output signal from Q1204 or Q1300 enters Q1203 base, inverts and outputs to J1201 (CH A SHAPED OUT). The output signal (CH A ECL) from Q1302 or Q1301 routes to the ECL logic circuitry (Diagram 3). An operational amplifier, U1202B (Diagram 2) sets the mean dc level of the ECL signal to the correct value. A threshold level generated by an ECL signal (Diagram 3) is sensed at pin 5, U1202B and compared to the mean level sensed at pin 6, U1202B. The output (pin 7, U1202B) supplies the current necessary to adjust the level shifted output to the correct mean ECL threshold level.

MAIN GATING—DIAGRAM

The microprocessor controls the measurement gate interval through the $\overline{\text{GATE}}$ signal going to pin 4 of U1110B. The IC's U1000C and U1000B operate as synchronizers to ensure that the accumulator gates, U1001C and U1110A open and close at the proper time for the desired measurement. Synchronizing the accumulator gates with the signals to be counted ensures that the accumulators will contain a count corresponding only to a whole number of input and time-base pulses. In the absence of the synchronizers, the gates would sometimes pass fractional pulses, and the count chains might not be able to make a reliable count. The signals to be counted clock the synchronizers at pin 16, U1000C and pin 1, U1000B.

Before each measurement is initiated by the microprocessor, U1000C and U1000B are set by a MR_1 (Master Reset) pulse on connector J1010 pin 1. The IC's U1001C and U1110A are thus disabled by the high level synchronizer outputs at pins 14 (U1000C) and 11 (U1000B) until the measurement begins.

For those modes that use the Channel A Amplifier with positive slope triggering, negative going edges are generated on pin 6 of U1001B. Pin 7 of shift register U1200 is latched high for all operating modes except the time interval modes (TIME A \rightarrow B, WIDTH A, RISE/FALL Time, and EVENTS B DUR A). With pin 7 of U1200 high, U1210D pin 12 is low, so Q1114 is enabled. The Channel A signal is then inverted by U1001C and clocks U1000A on pin 5. The Channel A complement signal appearing on pin 6 of U1001B, is inverted by U1001E and clocks the synchronizer flip flop U100C pin 16 after passing through U1001D.

NOTE

Transistors Q1110, Q1114, Q1111, Q1112 and Q1000 operate as switches to route the Channel A, Channel B, and 320 MHz time base signals through the proper logic gates for the selected front panel function. These transistors are either completely "on" or completely "off", depending on whether their base resistors are pulled high or low. Transistor Q1100 is used to disable U1001A. See Table 3-1.

FREQ A and PERIOD A

If the $\overline{\text{GATE}}$ signal from the microprocessor (U1200 pin 4) and the arming signal ($\overline{\text{ARM}}$) on J1102-1 are both low, a low is set on the D input (pin 15) of U1000C after passing through U1110B. This low is transferred to pin 14 on the first Channel A edge that clocks U1000C after the measurement gate started. The low on pin 14 enables the second synchronizer, U1000B, and the Channel A accumulator

gate, U1001C. With U1001C enabled, the next negative edge of the Channel A signal is allowed to pass through U1001C, gets inverted, and is counted by the first binary stage of the Channel A accumulator (U1000A, pin 5).

For the FREQ A and PERIOD A functions, pin 14 of shift register U1200 is latched low. This turns on U1110C and turns off Q1112, allowing the 320 MHz time base signal to clock U1000B on pin 1. The first positive time base edge to clock U1000B after U1000C changed state, sets a low on pin 11 of U1000B, enabling the Channel B accumulator gate, U1110A. The next negative edge of the 320 MHz time base signal then passes through U1110A in its inverted form and is counted by the first binary stage of the Channel B accumulator (U1011C).

Table 3-1
SIGNAL ROUTING SWITCHING LOGIC FOR U1200
(X = low, blank = high)
PIN NUMBERS

Function	11	12	13	14	7
FREQ A				X	
PERIOD A				X	
WIDTH A		X	X	X	X
TIME MAN				X	
TIME A \rightarrow B	X		X	X	X
RISE/FALL A	X		X	X	X
RATIO B/A	X				
TOTAL A, A+B, A-B	X				
PROBE COMP	X				
EVENTS B DUR A		X	X		X

After the synchronizers and accumulator gates have been enabled, all succeeding input pulses are counted by the Channel A accumulator and all succeeding time base pulses are counted by the Channel B accumulator.

The counting process continues until the selected number of averages have been satisfied or the time out period, while in the auto mode, has been satisfied. At this point, the gate signal from the microprocessor goes high, setting the D input (pin 15) of U1000C high. The next positive edge of the Channel A input signal then clocks U1000C and pin 14 goes high, disabling U1000B and U1001C. The next 320 MHz time base edge then clocks U1000B, disabling U1110C and sending $\overline{\text{END}}$ low alerting the microprocessor that the measurement cycle has ended.

When the measurement cycle has ended, the microprocessor reads the total counts in both accumulators. The Channel A accumulator contains the number of events or

periods and the Channel B accumulator contains the number of time base clock pulses counted over the same interval. The microprocessor divides the number of events in the Channel A accumulator by the total time in the Channel B accumulator to obtain the frequency (FREQ A) or divides the total time in the Channel B accumulator by the number of events in the Channel A accumulator to obtain the period, or time per Channel A event (PERIOD A).

RATIO B/A

The RATIO B/A mode is the same as FREQ A and PERIOD A, except that instead of counting 320 MHz time base pulses, U1110C is disabled by a high on pin 14 of shift register U1200, and Q1112 is enabled by a low from inverter U1210E. This allows the Channel B signal to clock U1000B. The counts are accumulated over the time interval determined by the number of averages selected. The RATIO B/A result is then calculated by dividing the number of Channel B events by the number of Channel A events. The AVGS exponent refers to the count in Channel A.

TIME A → B

For the TIME A → B function, Q1110 and Q1112 are disabled; Q1111, Q1114, Q1000, U1001E, U1110C, and U1001D are enabled. The first Channel A pulse slope that is selected, is inverted by U1001B, inverted again by U10001E, and then applied to pin 19 of U1001D. The synchronizers have been set by the MR₁ (Master Reset) pulse and the Channel A pulse clocks on pin 16 of U1000C.

As soon as the gate signal from the microprocessor sets pin 4 of U1110B low, the next Channel A clock edge to U1000C transfers the low on pin 15 to pin 14 and sets pin 13 high. The high on pin 13 passes through Q1000, disables U1001E, and prevents U1001D from being clocked by succeeding Channel A pulses. The Q output of U1000C (pin 14), being low, enables U1001A and allows the first succeeding Channel B pulse edge to clock U1000C via U1001D, setting pin 14 high and pin 13 low again. Pin 13, going low with the Channel B edge, also re-enables U1001E again for the next Channel A edge to clock U1000C.

During the period of time that pin 14 of U1000C is low, U1000B is enabled. The 320 MHz time base clock pulses are synchronized and gated by U1000B and U1110A, and then counted by the binary stages in the Channel B accumulator, beginning with U1011C.

Since Q1114 is disabled, U1001C is enabled with a low on pin 17 and also enabled each TIME A → B interval appears as a negative pulse on pin 18. This negative time interval pulse is converted to a positive time interval pulse by U1001C and then counted by the binary stages in Channel A accumulator. Thus, for each TIME A → B interval, a

count is accumulated in the Channel A accumulator; and during each of these intervals, the 320 MHz clock pulses are accumulated in the Channel B accumulator.

The microprocessor is continually reading the counts (accumulated time intervals) in the Channel A accumulator. When it finally reads a count greater than or equal to the selected number of averages (10^N) or when the measurement time in the auto mode (≈ 0.3 seconds) has been satisfied, the microprocessor sets the gate signal on pin 4 of U1110B to a high level. The next Channel A pulse clocks a high through U1000C to pin 18 of U1001C and disables U1000B. The next 320 MHz clock pulse then toggles U1000B, disabling U1110A and allows the END signal line (J1102-1) to go low. This alerts the microprocessor that the measurement cycle has been completed. The microprocessor then makes a final reading of both accumulators, divides the total time by the number of intervals, and updates the display during the next measurement cycle.

WIDTH A

The WIDTH A function is essentially the same as the TIME A → B except that Q1110 is enabled. This then allows the leading edge of the Channel A pulse width to be measured, and applied to pin 23 of U1001E and the training edge to be applied to pin 2 of U1001A, through the 3.5 ns delay line (DL 500).

The synchronizers (U1000C and U1000B) and the accumulator gates (U1001C and U1110A) function exactly like they did in TIME A → B. The pulse widths are regenerated on pin 14 of U1000C and during each of the negative pulse intervals, U1000B and U1001C are enabled so that the 320 MHz clock pulses (via Q1110C) can be counted by the Channel B accumulator. Also, each regenerated pulse is passed through U1001C and counted by the Channel A accumulator. Again, when the average conditions have been satisfied, the microprocessor stops the measurement gate, reads both the accumulators, and divides the total time by the number of regenerated time intervals to obtain the average pulse width.

EVENTS B DUR A

The EVENTS B DUR A function is the same as WIDTH A except that instead of counting 320 MHz clock pulses via U1110C, the instrument is counting Channel B events during the selected Channel A pulse width via Q1112. To do this, Q1110, Q1112, and Q1000 are enabled. The leading and trailing edges of the Channel A pulse are again applied to pin 23 of U1000E and pin 2 of U1001A.

The Channel B signal passes through Q1112 to clock the second synchronizer, U1000B. When the gate signal on pin 15 of U1000C goes low, the synchronizers and accumulator

gates function exactly as they did in WIDTH A (and described for TIME A \rightarrow B). With U1001C enabled on pin 18, the Channel A pulse widths are counted in the Channel A accumulator while the Channel B events are counted in the Channel B accumulator. In EVENTS B DUR A the instrument is counting Channel B events only during Channel A pulse widths and averaging by the selected number of Channel A events.

When the selected or auto averages condition has been satisfied, the microprocessor sends the gate signal on pin 15 of U1000C high. The next Channel A trailing edge disables U1000B (pin 2 high) and the succeeding Channel B edge sets a low on pin 12 of U1000B. This completes the measurement cycle.

TIME MANUAL and TOTALize A

For the TIME MAN and TOTAL A functions, the microprocessor asserts the gate signal on pin 15 of U100C after the MEASUREMENT START/STOP pushbutton on the front panel is pressed to start the measurement. The gate is unasserted (set high) when the pushbutton is pressed to stop the measurement.

For the TIME MAN function, Q1114, Q1100, and U1110C are enabled. Immediately after asserting the gate signal, the microprocessor momentarily changes the Channel A triggering slope from its current setting to the opposite setting and then back again. This change provides an artificial Channel A signal that enables U1000C and allows the 320 MHz clock signal count to be accumulated in the Channel B accumulator. The accumulation continues until the measurement is stopped, at which time the microprocessor unasserts the gate signal and provides another trigger slope change to disable U1000C. This stops the accumulation of time base clock count. Throughout the measurement, the B Channel is continually red and then directly displayed with the proper annunciator illuminated.

While taking this reading, the display will occasionally flicker during the measurement. This is not the result of miscounting by the Channel A or Channel B accumulators; the correct count will be displayed when the measurement is finished.

For the TOTAL A function, Q1114, Q1100, and Q1112 are enabled. When the gate signal is asserted, Channel A events are counted (totalized) in the Channel A accumulator until the measurement is stopped. In this case, the microprocessor does not read the Channel B accumulator; only the Channel A accumulator counts are displayed. Display scaling is accomplished by the microprocessor using the AVGS setting to select the desired scaling factor (power-of-ten). This scaling is independent of the actual counting pro-

cess and can be changed during or after a measurement without affecting the count. Thus, the full 13 digits of the internal count chain can be examined by changing the AVGS exponent. Time, frequency units, and decimal point are not displayed for this function.

PROBE COMP and TEST

For the PROBE COMP function, the operator applies probe compensating signals to either Channel A or Channel B. For either of these modes, the counter is set up (internally) in RATIO B/A mode. This allows the Channel A or Channel B signals to pass straight through to the accumulators.

For the TEST function, the microprocessor generates artificial signals by programming the digital-to-analog converters (Diagram 6) through their full range. The outputs of the digital-to-analog converters are applied as trigger level changes to the differential amplifier circuits in the Channel A and Channel B Amplifiers (Diagram 2) and end up as counts in the two count chains. If an illegally large signal is present on an input (a signal beyond the range of the digital-to-analog converters), this process does not produce counts, and the TEST may fail. When a failure is indicated, all inputs should be disconnected and the TEST rerun.

A complete description of the self test function is in the Maintenance section. Front panel procedures for the PROBE COMP function are found in the Operating Instructions.

CHANNEL A AND CHANNEL B COUNT CHAINS—DIAGRAM 4

The Channel A and Channel B accumulators are two nearly symmetrical binary ripple counters, each having the capabilities for its contents being "read" serially by the microprocessor. Each accumulator begins with high speed ECL. Then, as the maximum toggle rates decrease, goes to medium speed ECL, then to LS TTL, and eventually CMOS. Wherever possible, a counter IC of a given family is shared: one half is used by Channel A and one half by Channel B.

The Channel A accumulator begins on the Analog board (A12) with signals clocking U1000A, pin 5 (see Diagram 3). The Channel B accumulator signal clocks U1011C, pin 1. The first two binary stages for each accumulator are ECL 100k and consist of U1000A and U1011A (Channel A) and U1011C and U1011B (Channel B).

The counts (CH A FAST and CH B FAST) are routed from the Analog board to the Digital board (A16) through coaxial cables (W520 and W530). The next two binary stages for each count chain are ECL 10k and use IC's

U1810A and U1801A (Channel A) and U1810B and U1801B (Channel B). Transistors Q1702, Q1701, Q1704, and Q1703, with associated circuitry, operate as fast ECL to LS TTL converters. These converters provide drive for the following LS TTL stages and must operate reliably up to 25 MHz. The counts in these (and the preceding) ECL stages must also be converted to CMOS levels for eventual readout by the microprocessor. However, since this conversion occurs long after the count chains have stopped counting and are stabilized, these translators need not be fast. The comparators U1710A, B, C, D and U1102A, B, and C have one input set at a voltage half-way between an ECL high and low. This voltage is set by resistors R1712 and R1710. With pull up resistors R1420 (fixed resistor network), R1207, R1208 and R1209 tied to +5 volts, the ECL transition from high to low (on the other input) results in a full CMOS swing on the comparators output. This results in a highly reliable translator that draws little power.

The next bit of each chain is a single LS TTL flip flop, U1120A, Channel A (U1120B, Channel B). Following this IC is an LS TTL 4-bit counter, U1113A, Channel A (U1113B, Channel B) followed by a lower power CMOS 4-bit counter, U1115A, Channel A (U1115B, Channel B). These stages, too, must be read by the microprocessor. The LS TTL outputs are pulled high by the fixed resistor network, R1014, to ensure valid CMOS levels to the serial readout circuitry. At this point, the two accumulator chains lose their symmetry (not for functional reasons but for more economical use of the components). The Channel A accumulator uses the 16-bit counter contained in U1410 (see Diagram 9). The Channel B accumulator (Diagram 4) uses 11 of the 12 bits available in the CMOS counter, U1212. The circuitry, described, provides a total of 29 hardwired bits for the Channel A accumulator and 24 hardwired bits for the Channel B accumulator. Since each accumulator requires 43 bits, the firmware counters supply 14 bits (Channel A) and 19 bits (Channel B) respectively.

Five CMOS parallel-to-serial shift registers consisting of U1121, U1114, U1122, U1211, and U1312 are used by the microprocessor to read out the contents of the Channel A and B accumulators. When the ILATCH control line (pin 9 of each register) is brought high, data are applied into the registers asynchronously with the clock. When pin 9 is brought low again, data can be shifted into (pin 11 of each register) and out of (pin 3 of each register) the registers synchronously with the positive transition of the SERIAL CLOCK signal (pin 10 of each register).

Before each measurement is initiated by the microprocessor, the MR (Master Reset) signal is asserted via pin 33 of U1410 (see Diagram 9). This reset signal is inverted by U1520D (Diagram 4) applying MR to pin 1 of U1120A. The $\overline{\text{MR}}$ signal is also inverted and buffered again by U1314D, U1314F, and U1520E to provide an ECL, LS TTL, and CMOS compatible reset signal (MR_1 signal also guarantees

the two synchronizer flip flops (located on Diagram 3), U1000C and U1000B, will begin set.

TIME BASE AND 320 MHz PLL-DIAGRAM 5

The 10 MHz standard time base consists of a 10 MHz crystal, Y1520, and a Colpitts oscillator circuit, Q1420, and associated components. The frequency of the standard time base is adjusted by variable capacitor, C1521 (accessed through the instrument's back plate).

The Option 01 high stability time base consists of a self contained, oven controlled 10 MHz oscillator, Y1530. This time base is adjusted via a hole in the rear of the case (accessed through the instrument back plate). The 18 volts input to the time base is derived from the fused +26 volts in the power module and regulated by a three-terminal regulator circuit, U1430, and associated components.

NOTE

The single-starred schematic diagram 5 components for the standard time base circuit are removed if the Option 01 time base circuit is installed.

The 10 MHz output signal from either the internal time bases or an external source (1, 5, 10 MHz) is applied to the base of Q1500. The buffered signal at the collector of Q1500 can be either 1 MHz, 5 MHz or 10 MHz. This signal is buffered again by U1500F. If the input signal frequency is 1 MHz, jumper plug P1510 (located on the Auxiliary board) connects pins 4 and 5 of J1510. A 5 MHz external input signal requires that IC U1411 divide-by-five ($\div 5$), therefore, P1510 connects J1510 pins 2 and 3 or pins 3 and 4. A 10 MHz time base signal requires U1411 to divide-by-ten ($\div 10$). Component P1510 then connects J1510 then connects J1510 pins 1 and 2. The signal to the base of Q1401, in all cases, must be 1 MHz.

Emitter follower Q1401 and associated components operate as a single-pole filter generating a sawtooth type signal at the negative input pin of comparator U1400. For the TIME A \rightarrow B, WIDTH A, and EVENTS B DUR A functions, the base of Q1300 is set low via pin 7 of shift register U1200 (as shown on Diagram 3). In these functions, the Noise Generator (Diagram 5), U1410, is enabled by applying +5 volts to the V_{SS} input, pin 4. The output from U1410 (pin 3) will be -12 volts to +5 volts signal with a pseudo-random edge distribution. This signal is then attenuated by resistor, R1410 and applied to pin 2 (+) of U1400. Also, with these functions, U1400 operates as a phase modulator circuit. The output (pin 7) of U1400 is a 1 MHz signal that is phase

modulated by the noise signal generated by U1410. For the other remaining functions, transistor Q1300 is turned off, U1410 is disabled, and U1400 operates only as a buffer stage.

The 1 MHz squarewave signal from U1400 (pin 7) is applied to pin 1, U1021 with the negative edge (falling edge) used as a reference edge for the Phase Locked Loop (PLL) U1021. This IC compares the signals negative edge (pin 1) with the positive edge (pin 3) and produces an output proportional to the phase difference between these two input signals. The output at pins 5 and 10 (U1021) is then filtered by a low pass filter with its bandpass providing the proper phase noise bandwidth for time interval measurements. This filter, U1030A with associated components, is amplified and inverted by operational amplifier U1030B. The amplifier output is a dc level proportional to the phase difference between the 1 MHz reference and the output of the PLL multiplier. The dc level voltage is coupled to a Colpitts oscillator circuit, Q1130 and associated components, and is inductor-tuned by the varactor diode, CR1130, and series capacitor C1032. The PLL adjusts the varactor diode voltage, which adjusts the oscillator frequency producing a precise 320 MHz output signal. The oscillator output is ac coupled to U1022A and a threshold reference voltage is generated by sensing the complementary outputs of U1022C through resistors R1021 and R1036. The voltage, at the junction of these two resistors, establishes this threshold reference at pin 3 of U1022A. The oscillator output rate on pin 3, produces a 320 MHz reference sinewave from pin 8. This sinewave is the clock that is counted for the different measurement modes of the counter. The 320 MHz signal is applied to pin 1 of U1022B (a set/reset latch that resets itself at 320 MHz, and buffers and provides proper ECL drive). This signal is then divided down to 160 MHz at pin 12, Q1022B. Another divide-by-two ($\div 2$) IC, U1022C, results in an 80 MHz output. This output is ac coupled to U1020, pin 7 and divided-by-eighty, ($\div 80$) producing the 1 MHz signal at pin 2. Any error in output at pin 2 of U1020 is sensed by U1021. This sensed voltage, applied to varactor diode CR1130, adjusts the Colpitts oscillator producing the precise 1 MHz signal at pin 3 of U1021.

D/A's, 50 Ω PROTECT, AND ARMING DIAGRAM

The isolation resistors for the 50 Ω Protect A (B) sense lines were discussed earlier (Diagram 1). The sense lines are routed from the Analog board to the Auxiliary board via jacks J1510 and J1520.

The 50 Ω Protect circuit is composed of a quad comparator (U1111) with associated components. Two of these comparators are arranged as "window" comparators (Channel A and B), that receive the protect sense levels from the Channel A or B inputs. These voltage sense levels normally

operate within a ± 2 V window. If the sense levels go outside this window (high or low), the comparator output changes states (to a low state) and issues a 50 Ω A (B) PROTECT signal to the microprocessor. The microprocessor recognizes this protect line and automatically changes the input relays from the 50 Ω TERM to the 1 M Ω TERM.

Trigger levels (CH A LEVEL and CH B LEVEL) are established, using a 10-bit D/A converter, U1210 and U1310 (Channel A and B). The data (SERIAL DATA lines) are received from the microprocessor through serial-to-parallel converters U1010 and U1020 (Channel A and B - see Diagram 7). These parallel output lines (Diagram 6) form the digital word that is applied to the D/A converter. The digital word corresponds to a unique current that is sunk at pin 3 of the D/A converters (U1210, Channel A; U1310, Channel B). This current, appearing at pin 2 of the operational amplifier circuits, U1200A (Channel A) and U1200B (Channel B), is converted to a voltage. This voltage can be offset by potentiometer R1205, (R1207, Channel B) and the voltage range adjusted by potentiometer R1204 (R1206, Channel B). The output of U1200A (U1200B) at pin 1 is the trigger voltage that is routed to the amplifier circuitry on the Analog board (see Diagram 1).

The arming circuit input load (Diagram 6) is 1 standard TTL load. The input is positive overvoltage protected by diode CR1510 (reverse biases upon receiving an excessive positive overvoltage). Diode CR1511 is the negative overvoltage protection component (clamps the output to a diode below ground) and is current limited by resistor R1500.

Transistors Q1510 and Q1511 form a Schmitt trigger providing noise immunity to the arming inputs (ARM In and EXT ARM IN). The ARM output signal is routed to the digital circuitry (Diagram 3).

RELAY DRIVE-DIAGRAM

The serial-to-parallel converters, U1010 (Channel A) and U1020 (Channel B), are used to change the serial data from the microprocessor to the parallel data. This data will select the particular relay to be activated. The converter output data are applied to U1110 (U1020, Channel B) that consists of seven Darlington NPN transistors (shown as inverters). These devices are used as current sinks to drive the relay coils. With one end of the selected relay coil brought low via one of the inverters (U1110), a voltage pulse is applied to the opposite coil end. This voltage pulse is generated by the microprocessor (see Diagram 9) and then amplified and regulated by the pulse amplifier circuit consisting of transistors Q1031, Q1030, Q1032 and associated circuitry (Diagram 7). The pulse is approximately 8 V in amplitude with a 25 ms width; therefore, when a relay coil is energized, the inverter output is brought low and the microprocessor pulses the

pulse amplifier to direct the current flow to the selected relay coil. This causes the relay to change state and latch.

The Darlington transistors, Q1121 and Q1120 (with associated circuitry), are used to drive the relay coils, K1612 (K1632, Channel B), that provide for the Common Separate channel input function (see Diagram 1).

POWER SUPPLIES—DIAGRAM

The four main supplies derive power input (through the instrument's two rear interface connectors) from the TM 5000-Series power module. These primary supplies are the +12 V and +5 V, located on the Auxiliary board, and the other +5 V and a -12.2 V, located on the Digital board. They are individually fused and current limited. The four supplies are referenced to the +2.5 V (Master Reference) precision voltage reference supply on the Auxiliary board.

The secondary supplies include the +2.7 V (ECL Termination), +5.7 V (derived from the +12 V supply), -5 V (three-terminal regulator derived from the -12.2 V supply), and the +18 V (three-terminal regulator derived from the +26 V from the power module) that is used in the Option 01 timebase only (see Diagram 5).

The +12 V supply (located on the Auxiliary board - Diagram 8) is derived from the unregulated +26 V dc power in the power module. The +12 V regulator circuit consists of U1420 and associated components. Load current for this supply passes through resistor R1425 (current limit sensing component) and the PNP series-pass transistor located in the power module. The +12 V supply is regulated within design limits by varying the voltage on the base of the series-pass transistor via P1600 pin 11A. The Zener diodes, VR1410 and VR1411, reduce the voltages to appropriate levels for U1420. Should the load current exceed 0.4 A, the voltage drop across R1425 becomes great enough to current limit U1420. This voltage is sensed at U1420 (pins 2 and 3) and reduces the base-to-collector voltage of the series-pass transistor. Feedback signals for voltage regulation of the +12 V supply appear on pin 4 (U1420) and are compared with the +2.5 V reference voltage on pin 5. Capacitor C1310 provides for frequency compensation.

Emitter follower Q1330 uses pin 6 (V_{ref}) of U1420 to provide an input voltage for the precision voltage reference, U1223. The +2.5 output voltage is used for all major supplies and is a master reference source for the D/A's.

The +5 V supply (located on the Auxiliary board) is derived from the unregulated +8 V dc power in the power module. The +5 V regulator circuit consists of U1320 and

associated components. Load current for this supply passes through current limit sensing resistor R1426 and the NPN series-pass transistor (located in the power module). This supply is also regulated by varying the voltage on the series-pass transistor base (P1600 pin 6A). If the load current is exceeded, the voltage drop across R1426 will cause U1320 to limit this current. This voltage (sensed at pins 2 and 3 of U1320) causes the series-pass transistor to eventually turn off. The feedback signal for the voltage regulator occurs on pin 4 (U1320) and is compared to the reference voltage on pin 5. Capacitor C1320 provides for frequency compensation.

The other +5 V supply (located on the Digital board) is identical in operation to the +5 V supply just discussed. It consists of the regulator, U1720 and associated components, and an NPN series-pass transistor (located in the power module). An additional filter network consisting of C1022 and L1020 provides the display power and isolates its noise from the rest of the instrument.

The -5 V supply (located on the Auxiliary board) consists of a three-terminal regulator, U1330, that provides regulated -5 V from the -12.2 V input.

The +2.7 V supply (located on the Auxiliary board) is the ECL termination supply and is used as a terminating supply for all the pull-down resistors located in the ECL circuits on the Analog board (see Diagrams 3 and 5). The +2.7 V supply is derived from the +5 V supply and consists of an error amplifier, Q133, an amplifier stage, Q1331, an emitter-follower output stage, Q1332, and associated components.

The -12.2 V supply (located on the Digital board) is derived from the unregulated -26 V dc power in the power module. This supply consists of error amplifier Q1723 and Q1722, error signal amplifier Q1721, current limit sense amplifier Q1720, and associated components. The reference voltage on the base of Q1723 is approximately 0 V. Diode CR1620 provides temperature compensation for the error amplifier circuit. This supply is regulated within design limits by varying the voltage on the base of the PNP series-pass transistor, located in the power module, via the collector of Q1721. An excessive load current through current limit resistor R1718 causes Q1720 to increase conduction and the bases of Q1723 and Q1721 to go more negative. The PNP series-pass transistor base goes more positive, thereby reducing the load current below the design limit.

PROCESSOR AND DISPLAY DRIVERS—DIAGRAM

Introduction

The DC 5010 is a digital counter based on a micro-computer system. The microprocessor, U1301 (located on

the GPIB board - Diagram 12), controls the internal operations of the DC 5010. The microprocessor recognizes, accepts, and decodes commands (keypushes and control setting) from the front panel logic circuits (Diagram 10) and sets the operating parameters in response to these commands.

Integrated circuit U1410 contains a random access memory (RAM) space that provides a maximum of 128 locations (addresses) which the microprocessor uses to temporarily store 8-bit data bytes. The data are not permanent and will be lost whenever the instrument power is turned off. When power is first applied, the RAM data occur as random bits and are therefore meaningless. During instrument operation, the microprocessor writes data into the RAM at various addresses for later recall and use.

The instructions for the microprocessor concerning GPIB operation are stored in the EPROMS U1102 and U1201 (located on the GPIB board). These IC's each contain 4 k bytes memory. The instructions (firmware) concerning manual operation of the DC 5010 are stored in EPROM U1610 (also a 4 k byte memory) and in the ROM section of U1410 (a 2 k byte memory). The other RAM is located in U1311 (located on Digital board) and U1210 (located on the GPIB board).

System Clock

The microprocessor, U1301, contains a single phase internal clock generator at pins 37 and 39, whose 1 μ s period (approximately) is controlled by inverter U1312D and the rc feedback network consisting of R1301 and C1302. The activity of U1301, when it is reading data from or writing data to a memory device, occurs in machine (U1301) cycles. Since no critical system timing relies on the microprocessor clock, a crystal is not needed.

Power Up Reset Cycle

When the instrument is powered up, comparator U1102D (and associated components) operates as a delay/comparator circuit to provide a pulse to reset the microprocessor to its reset vector address location.

Pin 14 of U1102D is held low for approximately 1.5 seconds (to allow all supplies to come up to operating status in the TM 5000-Series power modules). During this time all of the internal registers of U1410 (except the 16-bit counter and serial shift register) are cleared to logic zero. This action places all of the bidirectional input/output lines of U1410 in the input state and disables the internal shift register, Display Interrupt Clock input (pin 37), and the interrupt output (pin 4). Also, during the low level period of the microprocessor reset signal, the writing of data to or from U1301 is inhibited, and a bright digit may be displayed on the DC 5010's front panel.

When the positive edge is detected on pin 1 of U1301, the internal mask interrupt flag will be set and the microprocessor will load its internal program counter from the reset vector address listed in Table 3-2. This is the start location for program control.

Interrupt Vector (IRQ)

Integrated circuit U1410 has two internal registers for interrupt control, an interrupt enable register and interrupt flag register. Corresponding bits in these registers are logically ANDed to set an interrupt request pending flag. When U1410 detects the pending flag bit, it asserts pin 4 as a low output, generating an interrupt request to the microprocessor.

When a low level is set on pin 4 of U1410, the microprocessor completes the current instruction before recognizing the interrupt request and examining its own interrupt mask flag bit. If the interrupt mask flag bit is not set, the microprocessor starts an interrupt routine. The contents of its program counter and status register are temporarily stored in RAM, the interrupt mask flag bit will be set to prevent further interrupts, and the program counter will then be loaded with the high and low bytes of the interrupt vector address listed in Table 3-2. This is the start location for the interrupt routine for U1410.

Table 3-2
DC 5010 INTERRUPT VECTORS

Vector Address ¹	Type of Interrupt
FFFFC - \$FFFD	Power-Up Reset
FFFE - \$FFFF	Interrupt Request (U1410)

¹ Dollar sign (\$) indicates that address code is in hexadecimal notation.

There are three possible reasons why U1410 sets an interrupt pending flag, two external events and one internal event. The two external events are: a negative edge detected on pin 36 (CH B SLOW) or a negative edge detected on pin 37 (Display Interrupt Clock); the one internal event occurs when the 16-bit counter inside U1410 overflows.

Address Decoding

The microprocessor addresses U1610, U1410, and U1313 when communicating with the instrument functions. Table 3-3 lists the hexadecimal address ranges for these devices.

Table 3-3
DC 5010 MEMORY ADDRESS RANGES

Hexadecimal Address Range	Comments
\$0000 - \$007F	U1311 (128 X 8 RAM)
\$0080 - \$0087	U1313 (Front panel display, Serial data latches, and GPIB address switches)
\$0400 - \$04FF	U1311 (256 X 8 RAM)
\$0700 - \$070F	U1410 I/O ¹
\$0800 - \$0FFF	U1410 (2 k X 8 ROM)
\$1000 - \$1FFF	U1610 (4 k X 8 ROM)
\$C000 - \$C0FF	U1210 (256 X 8 RAM)
\$E000 - \$EFFF	U1102 (4 k X 8 ROM)
\$F000 - \$FFFF	U1201 (4 k X 8 ROM)

¹ See Table 3-4.

Memory select decoders U1313, U1420 and related components, operate to select the proper memory device during program control.

The input/output sections internal to U1410 are accessed by the microprocessor using address bits A0 through A3 for specific control of the internal functions. See Table 3-4.

NOTE

Due to the complexity of the internal functions associated with U1410, a detailed description of this device will not be attempted in this manual. If more detailed information is needed, refer to the manufacturer's data sheets.

Serial Data Path. The serial data path is shown on the block diagram (see Figs. 8-6 and 8-7). Serial data are written, via pins 38 and 40 of U1410, to five serial-to-parallel shift registers located on the Auxiliary circuit board (A18 assembly), and one serial-to-parallel shift register on the Analog board (A12) assembly. This is done when the microprocessor sets the instruments internal circuits for the desired function. These registers are, in sequence:

A18 – U1010	7
A18 – U1020	7
A18 – U1222	6
A18 – U1220	6
A18 – U1221	6
A12 – U1200	3

The serial data output from A12 – U1200 then goes, via P1102-6 (Diagram 3), to five parallel-to-serial shift registers (Channel A and Channel B accumulators) located on the Digital circuit board (A16 assembly). Serial data are shifted through these registers and returned to the microprocessor via the data buffer, U1310B. Serial data are read from the following parallel-to-serial shift registers:

A16 – U1122	4
A16 – U1211	4
A16 – U1312	4
A16 – U1121	4
A16 – U1114	4

Pin 40 of U1410 serves both as an input and output for serial data. When the microprocessor is in the serial write mode, pin 40 is configured as an output and bytes of information are loaded into the internal serial data registers of U1410. They are then shifted out serially to the shift registers on the A12 assembly (Analog board). During the writing of serial data the three-state data buffer, U1310B, is disabled with a high level on pin 15, preventing the serial data

Table 3-4
ADDRESS CODE FOR U1410

Address Bits				Internal Functions
0	0	0	0	Port A
0	0	0	1	Port B
0	1	0	0	Read Lower Counter/Writer Lower Latch
0	1	0	1	Read Upper Counter/Writer Upper Latch and Download
0	1	1	0	Write Lower Latch
0	1	1	1	Write Upper Latch
1	0	0	0	Serial Data Register
1	0	0	1	Interrupt Flag Register
1	0	1	0	Interrupt Enable Register
1	0	1	1	Auxiliary Control Register
1	1	0	0	Peripheral Control Register
1	1	0	1	Data Direction Register – Port A
1	1	1	0	Data Direction Register – Port B

input from contending with the serial data output via U1114-3. The microprocessor addresses U1313, causing a negative pulse on pin 14 ($\overline{\text{OLATCH}}$) to latch the serial data in the serial-to-parallel shift registers.

When the microprocessor is reading the serial data from the Channel A and Channel B accumulators, pin 15 of U1310B is set low at the same time pin 40 of U1410 is configured as an input. The serial data are then read in as five consecutive bytes. The microprocessor addresses U1313 and uses pin 15 ($\overline{\text{ILATCH}}$) to latch data during the serial read process.

Display Interrupt Clock. The front panel keyboard and displays are interrupt driven by the timing circuit consisting of U1520A, U1520B, and associated components. This circuit operates at approximately 1.1 kHz. The negative edges of the signal on pin 37 of U1410 interrupt the microprocessor, telling it to update the display and search for a new keypush or control setting. The microprocessor addresses U1313 and uses pins 7, 9, 10, 11, and 12 during this process.

Power Up Sequence. After the microprocessor and peripheral device U1410 have been reset at power up, the DC 5010 microprocessor generates the following sequence of events.

1. Loads a 0 in the most significant bit position of the front panel display.
2. Tests the RAM, starting at address \$0000. If a RAM failure is found, error code 340 will be displayed. The RAM on the GPIB board is similarly tested, starting at address \$C0000.
3. Tests the four ROMs for byte location and determines the checksum. If a ROM error is found, error code 361, 374, 375, 380, 381, 394, or 395 will be displayed.
4. Checks to see if the Channel A TERM button is held in, and, therefore, if signature analysis (SA) is being requested. If the SA is not requested, the interrupt registers in U1410 are enabled.
5. Initializes peripheral device U1410.
6. Performs a serial input/output test. If an error is found, error code 313 will be displayed.
7. Sets up the hardware to determine the state of the front panel, loads the serial-to-parallel shift registers, and generates the relay strobe signals via pin 26 of U1410.
8. Performs the counter chain (Channel A and Channel B accumulators) integrity test. If this test fails, an error code (320 through 324 and 329 for Channel A or 330 through 334 and 339 for Channel B) will be displayed.
9. Starts the measurement cycle by pulsing the master reset line (pin 33 of U1410).
10. After the master reset pulse, the measurement gate on pin 4 of U1200 (Diagram 3) is started. During the measurement gate interval, the microprocessor is continually reading the contents of the Channel A accumulator for a count that is greater than or equal to the number of averages requested by the user. When that count is reached, the measurement gate is unasserted and the microprocessor waits for the signal on pin 35 of U1410 to go low, indicating the end of the measurement cycle. The accumulators are then read again for their final count and a new measurement cycle is started after the result is calculated and the display is updated.

Rear Interface Signals. The $\overline{\text{PRESCALE}}$ for U1410 (pin 29) operates as an input that indicates to the microprocessor the presence of an external prescaling counter. When an external prescaler is used, the microprocessor multiplies the Channel A accumulated counts by 16 before the display is updated.

The microprocessor interprets the reset input from U1500A (Diagram 6) to pin 32 of U1410 as the electrical equivalent of the front panel MEASUREMENT START/STOP pushbutton.

NOTE

Complete data for all of the rear interface signals are given in the Maintenance section of this manual.

PUSHBUTTONS AND LEDs—DIAGRAM

The microprocessor uses five control lines and the 8-bit data bus to communicate with the Pushbuttons and LEDs and Display circuits. The five control lines are all derived from U1313 located on Diagram 9.

The interrupt signal from the Display Interrupt Clock (Timer) circuit to U1410 (Diagram 9, previously discussed) occurs approximately once every 900 μs . Each interrupt causes the microprocessor to start a software routine for servicing the Pushbuttons and LEDs, and Display circuitry.

Each digit and annunciator in the display, each push-button LED, and each control or pushbutton is assigned a time slot period approximately equal to the period between successive interrupts. The time slots are generated by U1121, a decade counter with 10 decode decimal outputs. The counter provides time slot decoding for scanning the front panel controls and multiplexing the seven-segment LEDs and LED annunciators located on Diagrams 10 and 11. The logic high outputs of U1121 are buffered by nine Darlington amplifiers (Q1121, Q1122, etc.)

Each interrupt signal causes the microprocessor to clock U1121 with a negative pulse of approximately 500 ns on pin 14, advancing the count to the next time slot. Immediately after clocking U1121, the microprocessor updates the digit associated with that time slot by sending data to U1112 and U1111, which contain six D-type flipflops each. Data are latched in U1112 and U1111 when pin 9 goes low and transfers to the outputs on the positive edge of the CLOCK signal. The BCD output of U1112 is then decoded to seven-segment information by U1101. Data latches into U1111 and are inverted and buffered by U1110 to drive the decimal point (DP), the pushbuttons, and annunciator LEDs. The display drive power supply filter is a pi-network consisting of C1022, L1020, C1020, and C1021 (Diagram 8). This filter circuit prevents display noise pulses from disturbing the sensitive instrument circuits.

After updating the display and checking the front panel status, the microprocessor returns to the routine of re-setting the input circuits (if necessary), monitoring the measurement cycle, or collecting the data for the selected function. This continues until the next front panel interrupt signal occurs, when it again clocks U1121 for the next time slot and repeats the procedure.

DISPLAY-DIAGRAM

The nine digits in the display are seven-segment, common anode LEDs; DS1001 is the Most Significant Digit (MSD) and DS1301 is the Least Significant Digit (LSD). The time slot lines (previously discussed) are generated by a nine-state decade counter, U1121 (diagram 10). The microprocessor sends all 1's (D1-D4) for the seven-segment information when leading zero suppression is indicated. All 1's are decoded by U1101 (Diagram 9) as a blank.

To illuminate the proper LED or indicator in the display, the microprocessor sets pins 9, 25, 30, 33, and 36 of P1001 low only during the time slot that corresponds to the displayed units of measurement or indicator.

The pushbutton switches are common to one of the four sense lines (MISC, FUNCTION, RELAYS, and MORE). The

microprocessor senses the switch closure during an active time slot (logic high) by addressing U1310 (tri-state buffer).

The illumination interval of the GATE light (DS1034) during time slot six, is only approximately equal to the actual measurement gate interval. The GATE light is turned on and then off only to tell the operator that the counter has been triggered and that the microprocessor has completed the functional measurement for the selected number of averages. The gate light is not directly connected to the actual hardware gate.

GPIB-DIAGRAM

The GPIB circuit board (A14 assembly), with microprocessor U1301, controls the operating system for the instrument.

Two ROMs (U1102, U1201), one RAM (U1210), and a 9914 GPIB controller IC (U1101) are used to communicate with the IEEE 488 Digital Interface.

The microprocessor recognizes, accepts, and decodes commands (keypushes and control settings) from the front panel logic circuits on Diagram 10 and sets the operating parameters in response to these commands.

The microprocessor is an 8-bit parallel processor with an 8-bit data bus (D0-D7, pins 26 through 33), and a 16-bit address bus, A0-A15 (pins 9 through 20 and pins 22 through 25). The data bus is bidirectional; the address bus is not. The address bus is used by the microprocessor to address the other internal functions of the instrument. The 16 address lines provide up to 76,000 discrete addresses, commonly referred to as 64 kilobytes of memory. Basically, any device addressed by the microprocessor is considered to be a memory device.

System Clock. The microprocessor contains a single phase internal clock generator (U1301, pins 37 and 39) whose 1 μ s period (approximately is controlled by inverter U1312D and the rc feedback network consisting of R1301 and C1302. An instruction cycle consisting of two to twelve machine cycles is required to fetch and execute the instruction words or data from memory. A machine cycle is defined as the interval between two successive negative-going transitions of the system clock. The number of machine cycles required depends on the instruction and addressing modes used for the microprocessor.

NOTE

Due to the complexity of the internal operation of the internal operation of a microprocessor, a detailed description of U1301 will not be attempted in this manual. If more detailed information is needed, refer to the manufacturer's data sheet.

Logic gate U1313B, along with address bit A15, is used to enable or disable the proper memory space during the communication process. When pin 5 of U1313B and pin 6 of U1311 are low (A15 = 0), the microprocessor is using the low memory space on the Digital board to communicate with the instrument's internal functions. When A15 is high (= 1), the upper memory space on the GPIB board is used to communicate with other instruments on the IEEE 488 Digital Interface. Logic IC U1311 operates as a three-line to four-line decoder to select the proper memory spaces that have starting addresses of C000, D000, E000, and F000 (see Table 3-5). The memory devices associated with these addresses are indicated as such on Diagram 12. The interrupt vector addresses for U1301 are FFFA through FFFF.

The GPIB controller, IC U1101, performs the interface functions between the microprocessor and other devices on the bus. Due to its internal architecture, it relieves the microprocessor from the task of maintaining the protocol as defined in the IEEE 488-1978 standard. The handshake process is handled automatically within U1101.

The GPIB output lines, pins 22 through 29 and 31 through 38 on U1101, are connected to the IEEE 488 bus via transceivers U1001 and U1002. The direction of data flow is controlled by the talk enable (TE, pin 21) and CONTROL-LEER (pin 30) outputs generated on U1101. Since the IEEE 488 controller function is not implemented in the DC 5010, pin 30 is always false (high). The TE line will be high for talk, low for listen. The TE and CONTROLLER outputs are routed within U1001 and U1002 so that the internal buffers for particular lines are controlled as required. Transistor Q1101 operates as an output buffer for the TE signal. Pins 9 and 10 on P1001 are not connected to the IEEE 488 Digital Interface; they are reserved for future use.

Communication between the microprocessor and U1101 is carried out with thirteen internal, memory-mapped registers in U1101. Fourteen internal registers are available, but one register (parallel poll) is not used. A microprocessor read operation passes control data back to U1301, while the write operation passes status information or measurement data to the IEEE 488 bus.

The three least significant address bits (A0, A1, A2) connected to pins 6, 7, and 8 of U1101 determine the particular register selected. The high order address bits (A15, A14, A13, A12) are decoded by U1311, U1312C, U1313A, and the system clock to cause pin 3 of U1101 to go low for a read or write operation on an internal register. Reading and writing to the same location will not access the same register within U1101, since they are "read only" or "write only" registers. When reading a register internal to U1101, the microprocessor sets pins 4 and 5 high; when writing to a register, pins 4 and 5 are set low.

Each device on the IEEE 488 interface is given a five-bit address (A1-A5) enabling it to be addressed as a talker or listener. The DC 5010 address and end-of-message terminator (TC) is set on S1210 (located on the digital board, Diagram 9) before power-up. The switch, S1210, located on the GPIB board (Diagram 12) is not used in the DC 5010. For more details, refer to the GPIB board (Diagram 12) and to the GPIB switch discussion in the Maintenance section. As part of the system initialization procedure, the microprocessor enables U1310, reads the address that was set, and stores it in an internal register of U1101. When U1101 detects the DC 5010 talk or listen address on the interface, it responds by entering the required addressed state and generating an interrupt signal ($\overline{\text{IRQ}}$, pin 9) to the microprocessor. Interrupts to the microprocessor from U1101 are generated by the following.

- A data byte has been received (byte input).
- U1101 is ready to accept the next (or first) data byte for output.
- EOI has occurred with ATN = 0.
- Interface Clear (IFC) has been received.
- A remote/local state change has occurred.
- A Group Execute Trigger command (GET) has been received.
- An Unidentified Universal command has occurred.
- An Unidentified Addressed command has occurred.
- Device Clear Active State (DCAS) has occurred.
- A Serial Poll Active State (SPAS) has occurred with data bit 7 set in the serial poll register.

NOTE

For more complete and specific details concerning the internal registers and architecture for U1101, refer to the manufacturer's literature for the 9914 microprocessor.

Table 3-5
DC 5010 MEMORY ADDRESS RANGES

Hexadecimal Address Range ¹	Comments
\$C000 - \$C0FF	U1210 (256 X 8 RAM)
\$D000 - \$D008	U1101 (GPIB IC)
\$E000 - \$EFFF	U1102 (4K X 8 ROM)
\$F000 - \$FFFF	U1201 (4K X 8 ROM)

¹ Dollar sign (\$) means that address code is in hexadecimal notation.

CALIBRATION

PERFORMANCE CHECK PROCEDURE

Introduction

This procedure checks the electrical performance requirements as listed in the Specification section in this manual. Perform the Adjustment Procedure if the instrument fails to meet these checks. In some cases, recalibration may not correct the discrepancy; circuit troubleshooting is then indicated. Also, use this procedure to determine acceptability of performance in an incoming inspection facility.

Calibration Interval

To ensure instrument accuracy, check the calibration every 2000 hours of operation or at a minimum of every six months if used infrequently.

Service Available

Tektronix, Inc. provides complete instrument repair and adjustment at local field service centers and at the factory service center. Contact your local Tektronix field office or representative for further information.

Test Equipment Required

The test equipment (or equivalent) listed in Table 4-1 is suggested to perform the Performance Check and Adjustment Procedure.

PRELIMINARY CONTROL SETTINGS

DC 5010

FREQ A	(lighted)
CHANNEL A and CHANNEL B	
SLOPE	+ (unlighted)
ATTEN	X1 (lighted)
COUPL	DC (unlighted)
TERM	1 M Ω (unlighted)

1. Check Oscillator Frequency (Standard Timebase)

NOTE

The timebase accuracy is a function of temperature and time. The temperature stability for the standard time base is ± 5 ppm (0°C to 50°C) with an aging rate of ± 1 ppm/year.

After one year of operation (since the time base was calibrated), the 1 MHz frequency standard should read 1.0000000, ± 6.0 ppm for any temperature between 0°C to 50°C . The ± 6.0 ppm are determined by ± 5 ppm due to temperature, ± 1 ppm due to aging, and ± 1 count to synchronization error. After this check is completed, the user should determine if a time base recalibration is required.

a. Connect a coaxial cable from the 1 MHz frequency standard output to the DC 5010 CHANNEL A input.

b. Press the DC 5010 AUTO TRIG button.

c. CHECK—that the DC 5010 readout is within 999.99399 kHz and 1.0000061 MHz (± 6.0 ppm, ± 1 count).

2. Check Time Base Oscillator Frequency (Option 01)

NOTE

The temperature stability for the Option 01 time-base is 0.2 ppm (0°C to 50°C) with an aging rate of ± 1 ppm/year and ± 1 count.

a. Connect a coaxial cable from the 1 MHz frequency standard output to the DC 5010 CHANNEL A input.

b. Press to light the DC 5010 FREQ A button, then press the AUTO TRIG button.

Table 4-1
LIST OF TEST EQUIPMENT REQUIREMENTS

Description	Performance Requirements	Perf. Check	Adj. Proc.	Example
Power Module		X	X	TEKTRONIX TM 5003 or TM 5006
Controller	GPIB compatible	X		TEKTRONIX 4050-Series or TEKTRONIX 4040-Series
Digital Multimeter	4 1/2 digits, 0.5%. Ranges: 2 k Ω –2 M Ω and 2-20 Vdc	X	X	TEKTRONIX DM 501A
1 MHz Frequency Standard	1 MHz $\pm 1 \times 10^{-9}$	X		SPECTRACOM CORP TYPE 8161
Leveled Sinewave Generator	Calibrated amplitude @ 350 mV. Frequency: >200 MHz	X		TEKTRONIX SG 503
Leveled Sinewave Generator	Calibrated amplitude @ 350 mV. Frequency: >350 MHz	X		TEKTRONIX SG 504
Function Generator	Range, sinewave 10 Hz to 1 MHz; offset ± 13 Vdc level	X	X	TEKTRONIX FG 501A
Pulse Generator	Risetime <1 ns. Amplitude 0–3 V	X	X	TEKTRONIX PG 502
50 Ω Feedthrough Termination	Bnc connectors	X	X	Tektronix Part No. 011-0049-01
Coaxial Cable, 50 Ω Precision 36 inch	Bnc connectors	X	X	Tektronix Part No. 012-0482-00
Coaxial Cable, 50 Ω Precision 18 inch	Bnc connectors	X		Tektronix Part No. 012-0076-00
Coaxial Cable, 50 Ω Precision 42 inch	Bnc connectors	X		Tektronix Part No. 012-0057-01
Adapter, Bnc Female To Dual Banana		X	X	Tektronix Part No. 103-0090-00
Cable Assembly RF (bnc-to-slide on connector)	50 Ω coaxial cable	X	X	Tektronix Part No. 175-3765-01
Probe, 5x		X		TEKTRONIX P6125
Flexible Extender			X	Tektronix Part No. 067-0645-02
Power Dividier GR		X		Tektronix Part No. 017-0082-00
GR To Bnc Female adapters (3)		X		Tektronix Part No. 017-0063-00
50 Ω , 10X Attenuator	Bnc connectors	X	X	Tektronix Part No. 011-0059-02
50 Ω , 5X Attenuator	Bnc connectors	X		Tektronix Part No. 011-0060-02
50 Ω , 2X Attenuator	Bnc connectors		X	Tektronix Part No. 011-0069-02
Connector, Dual Bnc		X		Tektronix Part No. 103-0029-00
Normalizer	20 pF	X		Tektronix Part No. 067-0538-00

c. CHECK—that the DC 5010 readout is within 999.99879 kHz and 1.0000020 MHz.

d. Remove all cable connections from the DC 5010.

b. Press the DC 5010 AUTO TRIG button, and then press LEVEL CH A.

c. Press the DC 5010 ↑ (increment) button until the digital multimeter display just changes to a low readout, if it is not already low. Press the DC 5010 ↓ (decrement) button until the digital multimeter display just changes to a high readout.

3. Check the Trigger Level CH A and CH B Accuracy

Refer to Fig. 4-1, performance check setup. Use the following control settings.

Digital Multimeter

Function-Range 2 V

DC 5010

CHANNEL A and
CHANNEL B

ATTEN X1 (lighted)

a. Connect the DC 5010 CH A SHAPED OUT to the digital multimeter input using the bnc-to-slide on connector assembly (standard accessory).

d. CHECK—that the DC 5010 display readout indicates between +0.040 and -0.040.

e. Connect a coaxial cable from the pulse generator output to the digital multimeter input using a bnc-to-banana adapter.

f. Set the pulse generator for Ext Trig and Ext Dur and adjust the output for a displayed readout of approximately +1.97 on the digital multimeter. Note this reading.

g. Disconnect the cable from the digital multimeter bnc-to-banana adapter and connect to the DC 5010 CHANNEL A input.

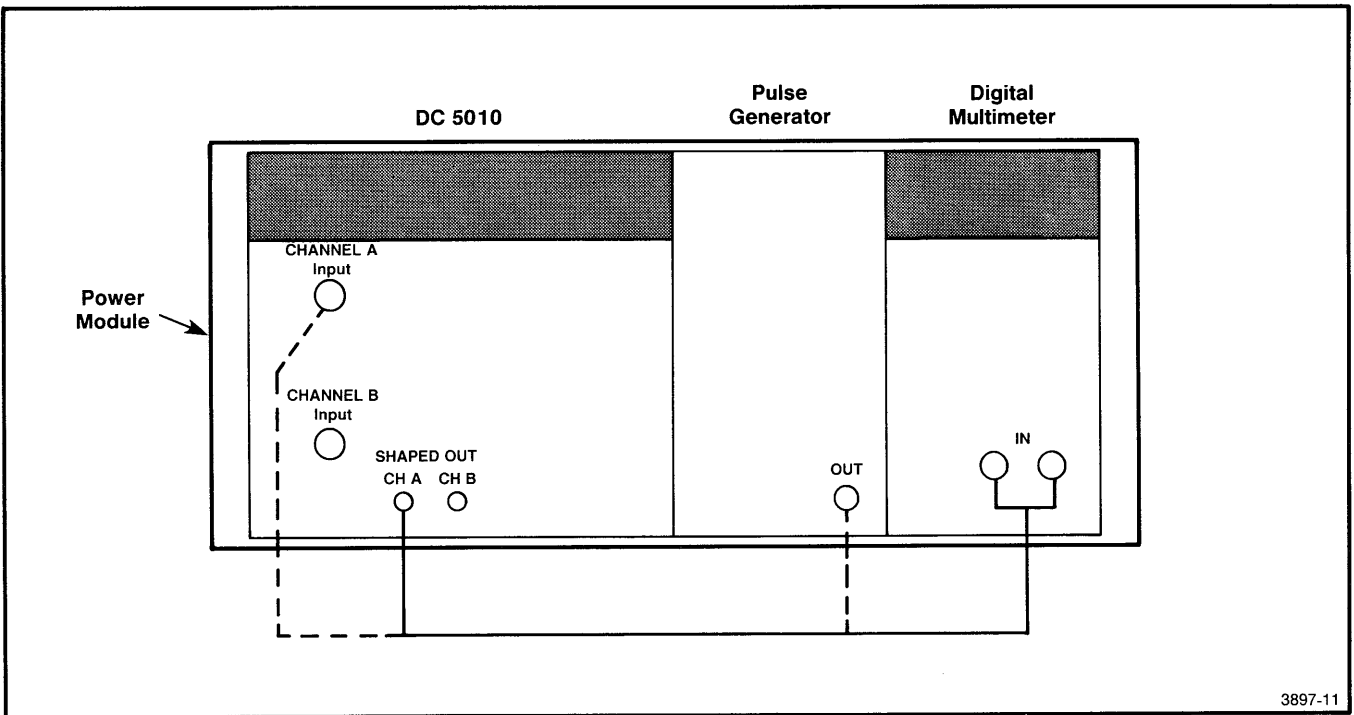


Fig. 4-1. Performance Check setup for step 3.

**Calibration—DC 5010
Performance Check Procedure**

h. Reconnect the accessory cable assembly to the digital multimeter input.

i. Press the \uparrow (increment) button until the digital multimeter display just changes to a low readout. Press the \downarrow (decrement) button until the digital multimeter display just changes to a high readout. Then press the DC 5010 AUTO TRIG button.

j. CHECK—that the DC 5010 display readout indicates the same value as was noted on step 3-f, ± 40 mV.

k. Repeat steps a through k using CHANNEL B.

4. Check Input Impedance: $50\ \Omega$, $\pm 3\%$; $1\ \text{M}\Omega$, $\pm 1\%$

Refer to Fig. 4-2 performance check setup. Use the following control settings.

Digital Multimeter

Function-Range $2\ \text{M}\Omega$

DC 5010

CHANNEL A and
CHANNEL B

ATTEN X1 (lighted)

TERM $1\ \text{m}\Omega$ (unlighted)

a. Connect a coaxial cable from the DC 5010 CHANNEL A input to the digital multimeter input using a bnc-to-banana adapter.

b. CHECK—that the digital multimeter display readout indicates between $.9800$ and $1.0200\ (\text{M}\Omega)$.

c. Press the DC 5010 CHANNEL A ATTEN X5 button (unlighted).

d. CHECK—that the digital multimeter display readout indicates between $.9800$ and $1.0200\ (\text{M}\Omega)$.

e. Change the digital multimeter Function-Range switch to $2\ \text{k}\Omega$.

f. Press the DC 5010 CHANNEL A TERM $50\ \Omega$ button (lighted).

g. CHECK—that the digital multimeter display readout indicates between $.0490$ and $.0510\ (\text{k}\Omega)$.

h. Press DC 5010 CHANNEL A ATTEN X1 button (lighted).

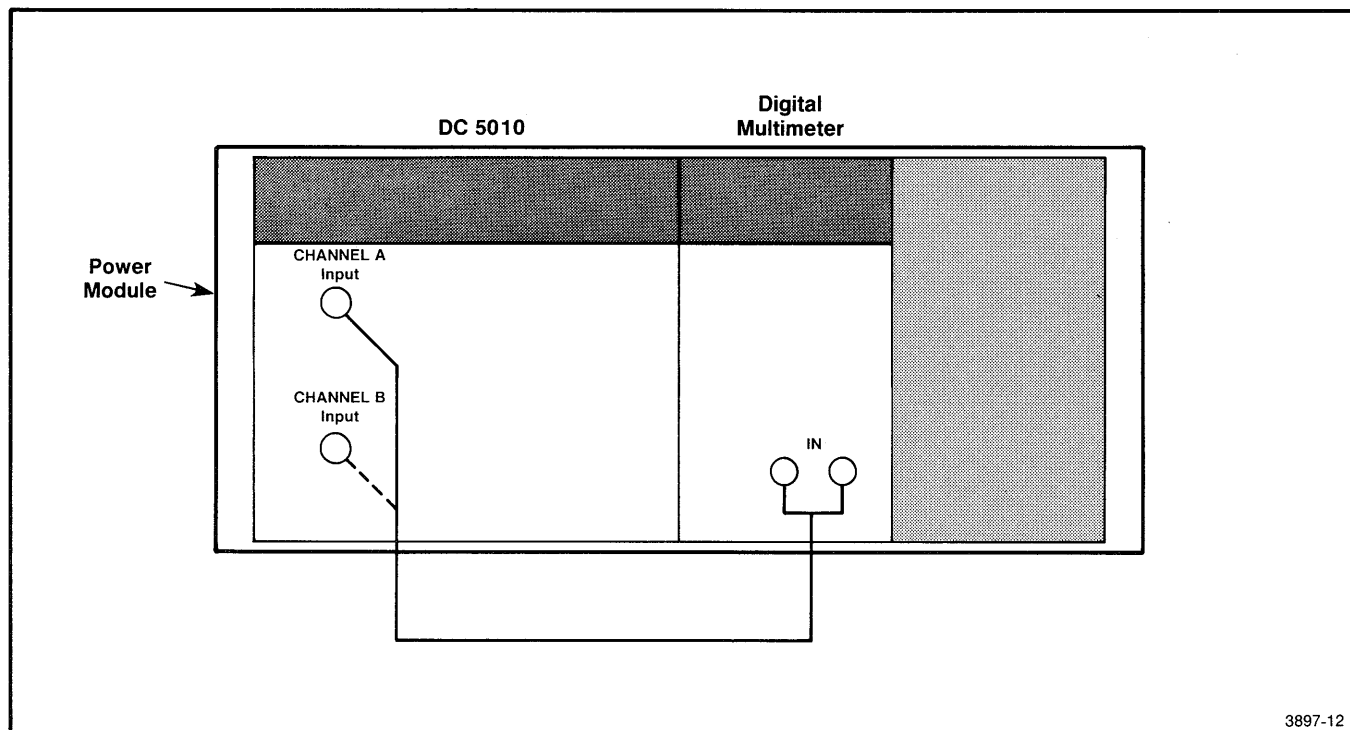


Fig. 4-2. Check setup for steps 4 and 7.

i. CHECK—that the digital multimeter display readout indicates between .0490 and .0510 (k Ω).

j. Move the cable connection from the DC 5010 CHANNEL A input to the CHANNEL B input.

k. Change the digital multimeter Function-Range switch to 2 M Ω .

l. CHECK—that the digital multimeter display readout indicates between .9800 and 1.0200 (M Ω).

m. Press the DC 5010 CHANNEL B ATTEN X5 button (unlighted).

n. CHECK—that the digital multimeter display readout indicates between .9800 and 1.0200 (M Ω).

o. Change the digital multimeter Function-Range switch to 2 k Ω .

p. Press the DC 5010 CHANNEL B TERM 50 Ω button (lighted).

q. CHECK—that the digital multimeter display readout indicates between .0490 and .0510 (k Ω).

r. Press the DC 5010 CHANNEL B ATTEN X1 button (lighted).

s. CHECK—that the digital multimeter display readout indicates between .0490 and .0510 (k Ω).

5. Check the Arming Input Pulse Response ≥ 100 ns ($V_H \geq 2.4$ V, $V_L \leq 0.4$ V)

Refer to Fig. 4-3, performance check setup. Use the following control settings.

Pulse Generator

Pulse Duration	Squarewave
Period	.1 μ s
Back Term	(in)

Sinewave Generator

Frequency Range (MHz)	50-100
Output Amplitude	1.25 V

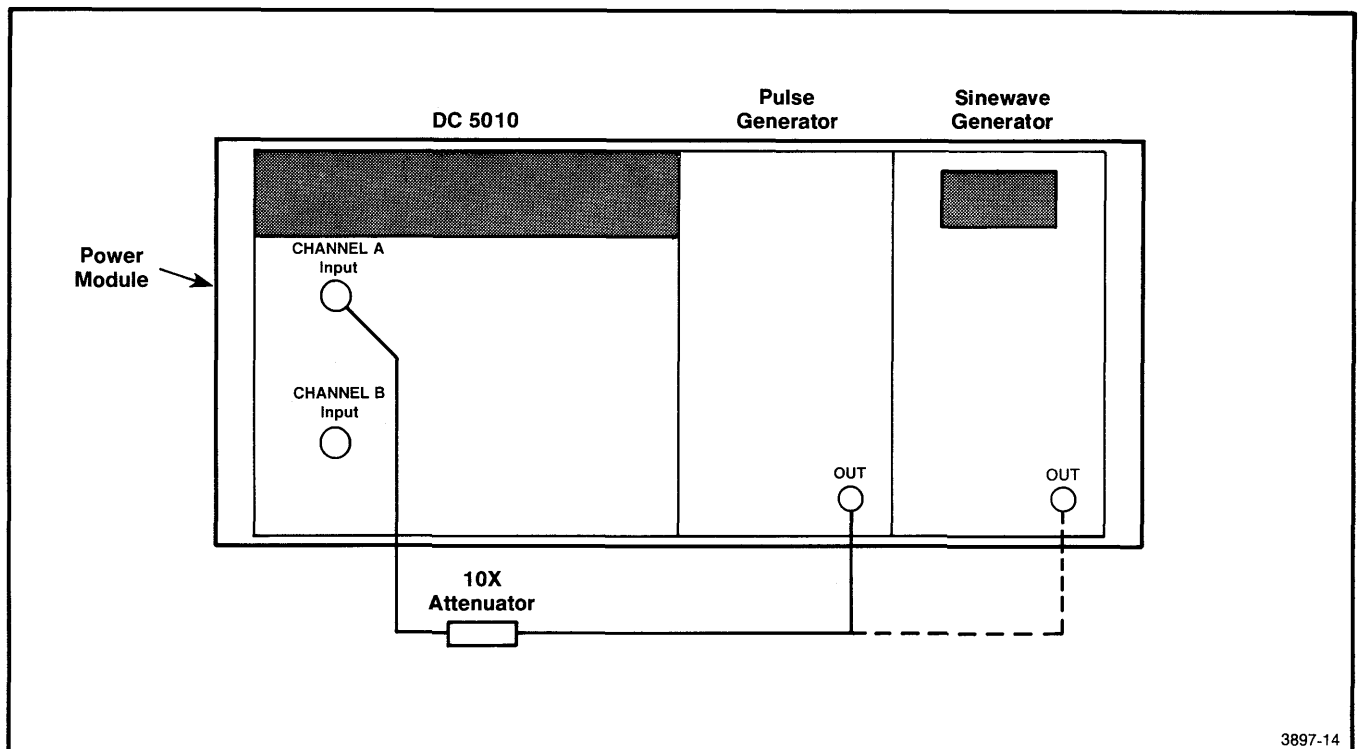


Fig. 4-3. Performance Check setup for steps 5 and 14.

Calibration—DC 5010
Performance Check Procedure

DC 5010

PERIOD A	(lighted)
CHANNEL A and	
CHANNEL B	
ATTEN	X1 (lighted)
TERM	50 Ω (lighted)

a. Connect a coaxial cable from the pulse generator output to the DC 5010 CHANNEL A input. Do not use the X10 attenuator for this test.

b. Adjust the pulse generator Period Variable control until the DC 5010 display readout indicates about 200 (ns).

c. Adjust the high level on the pulse generator for 2.5 V.

d. With the pulse generator High Level control set, adjust the Low Level control to ≤ 4 V.

e. Remove the DC 5010 CHANNEL A input connection and connect the sinewave generator output to the CHANNEL A input.

f. Set the DC 5010 to Freq A mode.

g. Adjust the sinewave generator Frequency Variable control until the DC 5010 display readout indicates approximately 75.0XXXX MHz (the last four digits can vary due to source instability).

h. Press the DC 5010 AUTO TRIG button, then connect the pulse generator output to the ARM IN, using a "shaped out" cable.

i. CHECK—that the DC 5010 display still indicates approximately 75.0XXXX MHz (the last four digits can vary due to source instability) with the display GATE light blinking.

j. Disconnect the cable that runs from the pulse generator to the counter arming input at the pulse generator end. At that end of the cable, connect a 50 Ω terminator (that will pull the arming input down to a TTL low, and hence should disable the counter).

k. CHECK—that the DC 5010 readout stops changing values and the display GATE light is not blinking (but may be lighted).

6. Check Input Capacitance: 23 pF, $\pm 10\%$

Refer to Fig. 4-4, performance check setup. Use the following control settings.

Function Generator

Frequency Hz	2
Multiplier	10 ²
Function	(sine)
Offset	(midrange)
Output	(cw)

DC 5010

CHANNEL A and	
CHANNEL B	
TERM	1 M Ω (unlighted)
SLOPE	+ (unlighted)
ATTEN	X1 (lighted)
COUPL	DC (unlighted)
FREQ A	(lighted)
FILTER (20 MHz)	(lighted)

a. Connect the 20 pF normalizer with a 50 Ω terminator and 5X attenuator from the DC 5010 CHANNEL A input through a coaxial cable to the function generator output.

b. Press the DC 5010 LEVEL CH A button.

c. Adjust the DC 5010 Channel A triggering level using the \uparrow (increment) button until the GATE annunciator light (on the display) just stops blinking.

d. Note the DC 5010 display readout (peak input voltage).

e. Change the function generator Multiplier switch to 10⁵.

f. Adjust the DC 5010 Channel A triggering level using the ↑ (increment) and ↓ (decrement) buttons until the GATE annunciator light (on the display) just starts or stops blinking (the new level should be lower.)

g. Note the DC 5010 display readout (peak input voltage).

h. Divide the readout on step 6d by the readout on step 6g.

i. CHECK—that the ratio between the two readings is between 1.03 and 1.13 (ratio of input capacitance value to the 20 pF normalization).

j. Press the DC 5010 LEVEL CH A button (to turn it off—unlighted).

k. Remove the DC 5010 CHANNEL A input connection and connect it to the CHANNEL B input. Change the function generator Multiplier switch to 10^2 .

l. Connect a cable from the CHANNEL B shaped out to the CHANNEL A input

m. Press Auto Trig, to trigger both channels.

NOTE

Step l and m allow the A Channel to tell us whether or not the B Channel is triggering.

n. Press the DC 5010 LEVEL CH B button.

o. Adjust the DC 5010 Channel B triggering level using the ↑ (increment) button until the GATE light (on the display) just stops blinking.

p. Note the DC-5010 display readout (peak input voltage).

q. Change the function generator Multiplier switch to 10^5 .

r. Adjust the DC 5010 Channel B triggering level using the ↑ (increment) and ↓ (decrement) buttons until the GATE light just starts or stops blinking.

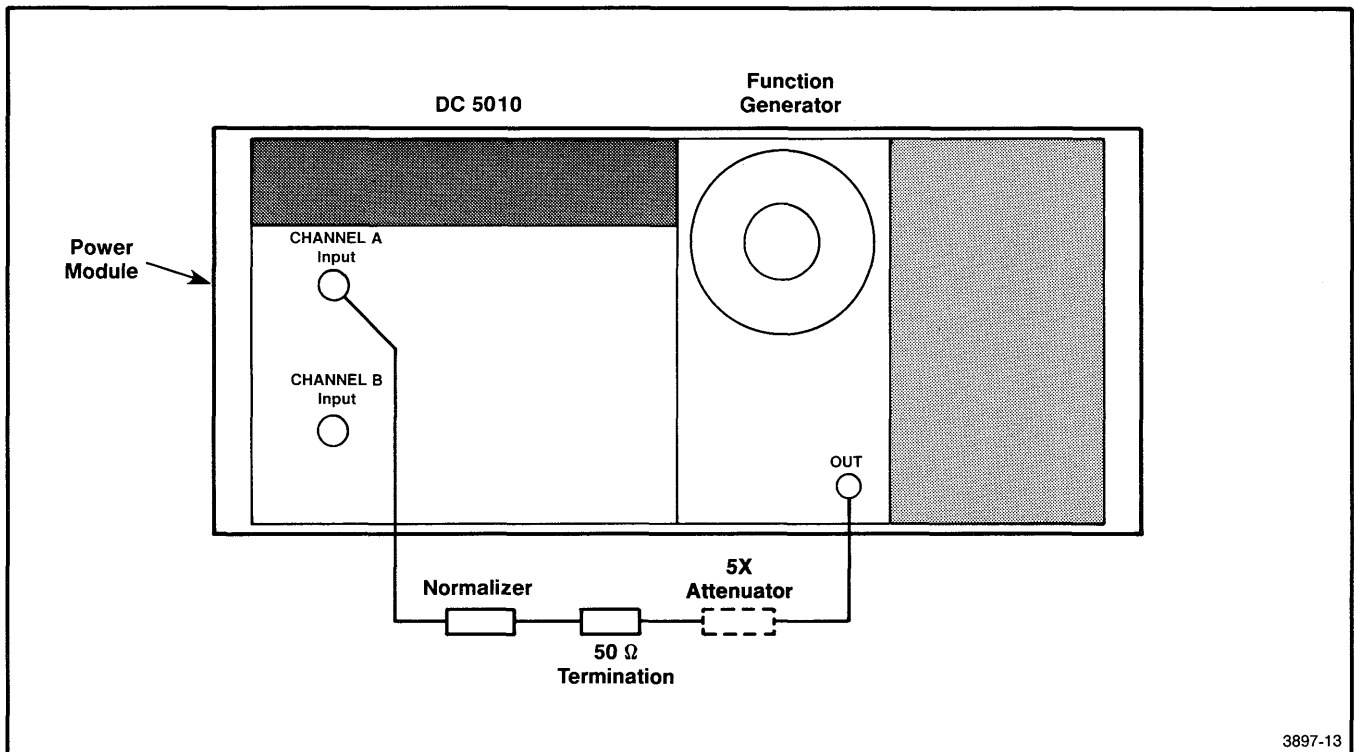


Fig. 4-4. Performance Check setup for step 6.

Calibration—DC 5010
Performance Check Procedure

s. Note the DC 5010 display readout (peak input voltage).

t. Divide the readout on step 6p by the readout on step 6s.

u. CHECK—that the ratio between the two readings is between 1.03 and 1.13 (ratio of input capacitance to the 20 pF normalization).

7. Check RISE/FALL Input Impedance: 50 Ω , $\pm 3\%$, 1 M Ω , 500 k Ω , $\pm 2\%$ (60 MHz sinewave at high level)

Refer to Fig. 4-2, performance check setup.

a. Set the digital multimeter Function Range switch to 2 k Ω .

b. Press the DC 5010 CHANNEL A ATTEN X1 button (lighted) and the 50 Ω button (lighted), and press to light the RISE/FALL A button.

c. CHECK—that the digital multimeter display readout indicates between .0490 and .0510.

d. Press both DC 5010 CHANNEL A and B TERM 1 M Ω buttons (unlighted).

e. Change the digital multimeter Function-Range switch to 2000 k Ω .

f. CHECK—that the digital multimeter display readout indicates between .4900 and .5100 (k Ω).

8. Check the Input Sensitivity: X1 Attenuation, DC and AC Coupled; 50 Ω , ≤ 70 mV p-p

Refer to Fig. 4-5, performance check setup. Use the following control settings.

Sinewave Generator

Frequency MHz	350
Range	LOW
Amplitude	0.70

DC 5010

FREQ A	(lighted)
CHANNEL A and B	
COUPL	DC (unlighted)
TERM	50 Ω (lighted)
SLOPE	+ (unlighted)
ATTEN	X1 (lighted)

a. Connect a coaxial cable with a 10X attenuator from the sinewave generator output to the DC 5010 CHANNEL A input.

b. Press the DC 5010 AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

c. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) buttons to adjust the trigger level for a stable display readout.

d. CHECK—that the DC 5010 display readout indicates approximately 350.00XXXX (the last four digits can vary due to source instability).

e. Move the DC 5010 CHANNEL A input connection to the CHANNEL B input.

f. Connect the 1 MHz frequency standard to the DC 5010 CHANNEL A input and press the RATIO B/A button (lighted).

g. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

h. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) buttons to adjust the trigger level for a stable display readout.

i. CHECK—that the DC 5010 display readout indicates approximately 350.00XXX (the last three digits can vary due to source instability).

9. Check the Input Sensitivity: X5 Attenuation, DC and AC Coupled; $50\ \Omega \leq 350\text{ mV p-p}$

Refer to Fig. 4-5, performance check setup. Use the following control settings.

Sinewave Generator

Frequency MHz	350
Range	Low
Amplitude	3.5

DC 5010

FREQ A	(lighted)
CHANNEL A and B	
TERM	$50\ \Omega$ (lighted)
ATTEN	X5 (unlighted)

a. Connect a coaxial cable with a 10X attenuator from the sinewave generator output to the DC 5010 CHANNEL A input.

b. Press the DC 5010 AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

c. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) buttons to adjust the trigger level for a stable display readout.

d. CHECK—that the DC 5010 display readout indicates approximately 350.00XXXX (the last four digits can vary due to source instability).

e. Move the DC 5010 CHANNEL A input connection to the CHANNEL B input.

f. Connect the 1 MHz frequency standard to the DC 5010 CHANNEL A input and press the RATIO B/A button (lighted).

g. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

h. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) buttons to adjust the trigger level for a stable display readout.

i. CHECK—that the DC 5010 display readout indicates approximately 350.00XXXX (the last three digits can vary due to source instability).

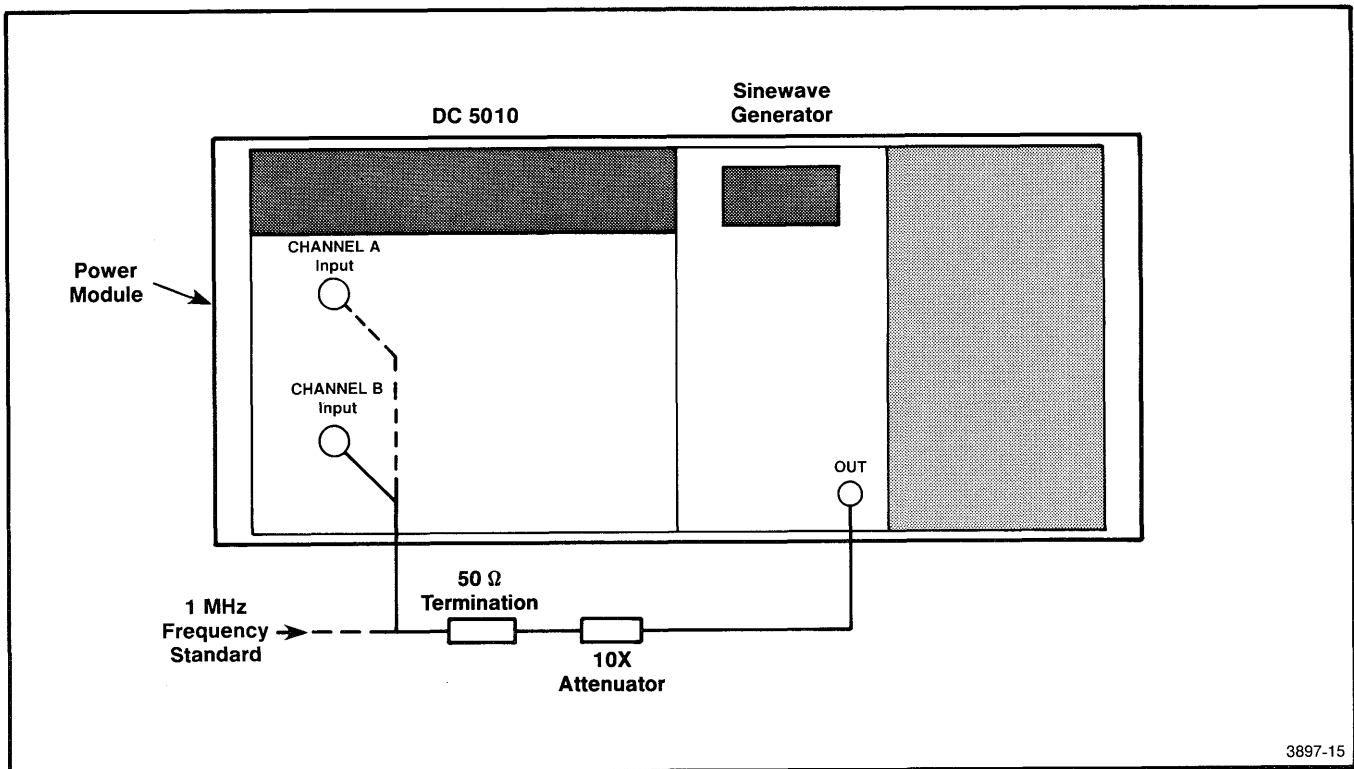


Fig. 4-5. Performance Check setup for steps 8, 9, 10, 11, 12, and 13.

10. Check Input Sensitivity: X1 Attenuation, DC and AC Coupled; 1 M Ω , \leq 120 mV p-p at \leq 300 MHz

Refer to Fig. 4-5, performance check setup. Use the following control settings.

Sinewave Generator	
Frequency MHz	300
Amplitude	\approx 120 mV
DC 5010	
CHANNEL A and B	
TERM	1 M Ω (unlighted)
ATTEN	X1 (lighted)

a. Remove the DC 5010 CHANNEL B input connection and attach a 50 Ω termination to the end of the coaxial cable. Reconnect this cable with the termination and 10 \times attenuator to the CHANNEL B input.

b. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

c. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

d. CHECK—that the DC 5010 display readout indicates approximately 300.0XXXX (the last four digits can vary due to source instability).

e. Remove the 1 MHz frequency standard from the DC 5010 CHANNEL A input.

f. Move the DC 5010 CHANNEL B input connection to the CHANNEL A input.

g. Press to light the DC 5010 FREQ A button, AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

h. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

i. CHECK—that the DC 5010 display readout indicates approximately 300.00XXXX (the last four digits can vary due to source instability).

j. Remove the cable connections.

11. Check Input Sensitivity: X5 Attenuation, DC and AC coupled; 1 M Ω , \leq 350 mV p-p at \leq 200 MHz

Refer to Fig. 4-5, performance check setup. Use the following control settings.

Sinewave Generator	
Frequency Range	100-250
Frequency Variable	200
Amplitude Multiplier	X1
Output Amplitude	3.5
DC 5010	
RATIO B/A	(lighted)
ATTEN	X5

a. Connect the 1 MHz frequency standard to the DC 5010 CHANNEL A input.

b. Connect a coaxial cable with a 10 \times attenuation and 50 Ω termination from the sinewave generator output to the DC 5010 CHANNEL B input.

c. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

d. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

e. CHECK—that the DC 5010 display readout indicates approximately 200.00XXX (the last three digits can vary due to source instability).

f. Press to light the DC 5010 FREQ A button.

g. Remove the 1 MHz frequency standard from the DC 5010 CHANNEL A input.

h. Move the DC 5010 CHANNEL B input connection to the CHANNEL A input.

i. Press the DC 5010 AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

j. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

k. CHECK—that the DC 5010 display readout indicates approximately 200.00XXXX (the last four digits can vary due to source instability).

12. Check Input Sensitivity: X1 Attenuation, DC and AC coupled; 1 M Ω , ≤ 70 mV p-p at ≤ 200 MHz

Refer to Fig. 4-5, performance check setup. Use the following control settings.

Sinewave Generator

Frequency Range	100-250
Frequency Variable	200
Amplitude Multiplier	X1
Output Amplitude	0.70

DC 5010

RATIO B/A (lighted)

a. Connect the 1 MHz frequency standard to the DC 5010 CHANNEL A input.

b. Connect a coaxial cable with a 10 \times attenuation and 50 Ω termination from the sinewave generator Output to the DC 5010 CHANNEL B input.

c. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

d. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

e. CHECK—that the DC 5010 display readout indicates approximately 200.00XXX (the last three digits can vary due to source instability).

f. Press to light the DC 5010 FREQ A button.

g. Remove the 1 MHz frequency standard from the DC 5010 CHANNEL A input.

h. Move the DC 5010 CHANNEL B input connection to the CHANNEL A input.

i. Press the DC 5010 AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

j. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

k. CHECK—that the DC 5010 display readout indicates approximately 200.00XXXX (the last four digits can vary due to source instability).

13. Check Input Sensitivity: X5 Attenuation, DC and AC Coupled: 1 M Ω , ≤ 594 mV p-p at ≤ 300 MHz

Refer to Fig. 4-5 performance check setup. Use the following control settings.

Sinewave Generator

Frequency MHz	300
Amplitude	≈ 594 mV p-p

DC 5010

CHANNEL A and B

TERM 1 M Ω (unlighted)

ATTEN X5 (unlighted)

a. Remove the DC 5010 CHANNEL B input connection and insert a 50 Ω termination to the coaxial cable. Reconnect this cable to the CHANNEL B input.

b. Press the DC 5010 AUTO TRIG button, LEVEL CH B button, and the DISPLAY-TEST button.

c. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

d. CHECK—that the DC 5010 display readout indicates approximately 300.00XXX (the last three digits can vary due to source instability).

e. Remove the 1 MHz frequency standard from the DC 5010 CHANNEL A input.

f. Move the DC 5010 CHANNEL B input connection to the CHANNEL A input.

g. Press to light the DC 5010 FREQ A button, AUTO TRIG button, LEVEL CH A button, and the DISPLAY-TEST button.

h. Press the DC 5010 \uparrow (increment) or \downarrow (decrement) button to adjust the trigger level for a stable display readout.

i. CHECK—that the DC 5010 display readout indicates approximately 300.00XXXX (the last four digits can vary due to source instability).

j. Remove the cable connections.

Calibration—DC 5010
Performance Check Procedure

14. Check Width A: Range ≤ 4 ns; Minimum Time Stop Edge To Start Edge, ≤ 8.5 ns

Refer to Fig. 4-3 (using sinewave generator only), performance check setup. Use the following control settings.

Sinewave Generator

Frequency	50 MHz
Output Amplitude	2.5 V p-p
Amplitude Multiplier	X1

DC 5010

CHANNEL A and B	
ATTEN	X1 (lighted)
TERM	50 Ω (lighted)
FREQ A	(lighted)

a. Connect a coaxial cable from the sinewave generator output to the DC 5010 CHANNEL A input. Do not use the attenuator shown in Fig. 4-3.

b. Press to light the LEVEL CH A button, and use \uparrow (increment) to set the CH A trigger level to .920 volts.

c. Press to light the DC 5010 WIDTH A button.

d. CHECK—that the DC 5010 display readout indicates between 2.000 and 6.000 (ns).

15. Check EVENTS B DUR A Minimum Pulse Width, ≤ 4.0 ns and ≤ 8.5 ns

Check Delay Mismatch: Int, ≤ 2 ns

Check Minimum TIME B \rightarrow A, ≤ 12.5 ns

Refer to Fig. 4-6, performance check setup. Use the following control settings.

Pulse Generator

Pulse Period	.1 μ s
Pulse Duration	≤ 2 ns
Low Level	0 V
High Level	3 V
Back Term	(out)

DC 5010

Time A \rightarrow B	(lighted)
CHANNEL A and CHANNEL B	
ATTEN	X1 (lighted)
TERM	50 Ω (lighted)
SLOPE	+ (unlighted)

EVENTS B DUR A check:

a. Connect a coaxial cable from the pulse generator output to one connector of a 50 Ω power divider (using the GR-to-bnc adapter).

b. Connect an 18-inch coaxial cable from another power divider connector to the DC 5010 CHANNEL A input (using the GR-to-bnc adapter).

NOTE

In this and other steps calling for exact lengths, it is important to use the lengths called for.

c. Connect a 42-inch coaxial cable from the other power divider connector to the DC 5010 CHANNEL B input (using the GR-to-bnc adapter).

d. Press the DC 5010 AUTO TRIG button, then press to light the NULL button.

e. Press the DC 5010 CHANNEL B — SLOPE button (lighted).

f. Adjust the pulse generator Duration Variable control until the DC 5010 display readout indicates between 3.95 ns and 4.05 ns.

g. Remove the DC 5010 CHANNEL B input cable and terminate this cable end with a 50 Ω terminator.

h. Set the sinewave generator for 300 MHz at approximately 150 mV, and connect the generator output to the DC 5010 CHANNEL B input.

i. Change the pulse generator Pulse Period to 10 ns range (pulse width setting remains at 4.0 ns).

- j. Press to light the DC 5010 FREQ A button.
- k. Adjust the pulse generator Period Variable until the DC 5010 display readout indicates 50.XXX MHz (the last three digits can vary due to source instability).
- l. Press to light the DC 5010 EVENTS B DUR A button, then press the AUTO TRIG button.
- m. CHECK—that the DC 5010 display readout indicates between 2.10 and 3.30.

p. Replace the 18-inch coaxial cable (from the DC 5010 CHANNEL A input to the power divider) with a dual bnc male connector.

q. CHECK—that the DC 5010 display readout indicates approximately 2.5 ns. Note this reading.

r. Replace the 42-inch coaxial cable (from the DC 5010 CHANNEL B input to the power divider) with the 18-inch cable that was removed in Step 15-p.

s. Press to light the DC 5010 TIME A → B button.

t. CHECK—that the DC 5010 display indication, minus (–) the readout noted in step 15-q, is 0.0 ± 2 ns.

Delay Mismatch Check:

n. Disconnect sinewave generator from CHANNEL B and reconnect the 42-inch cable from the power splitter to CHANNEL B, after having removed its 50 Ω terminator.

o. Press to light the DC 5010 TIME A → B button, then press the NULL button (lighted).

Minimum Time B → A Check:

u. Press to light the DC 5010 FREQ A button.

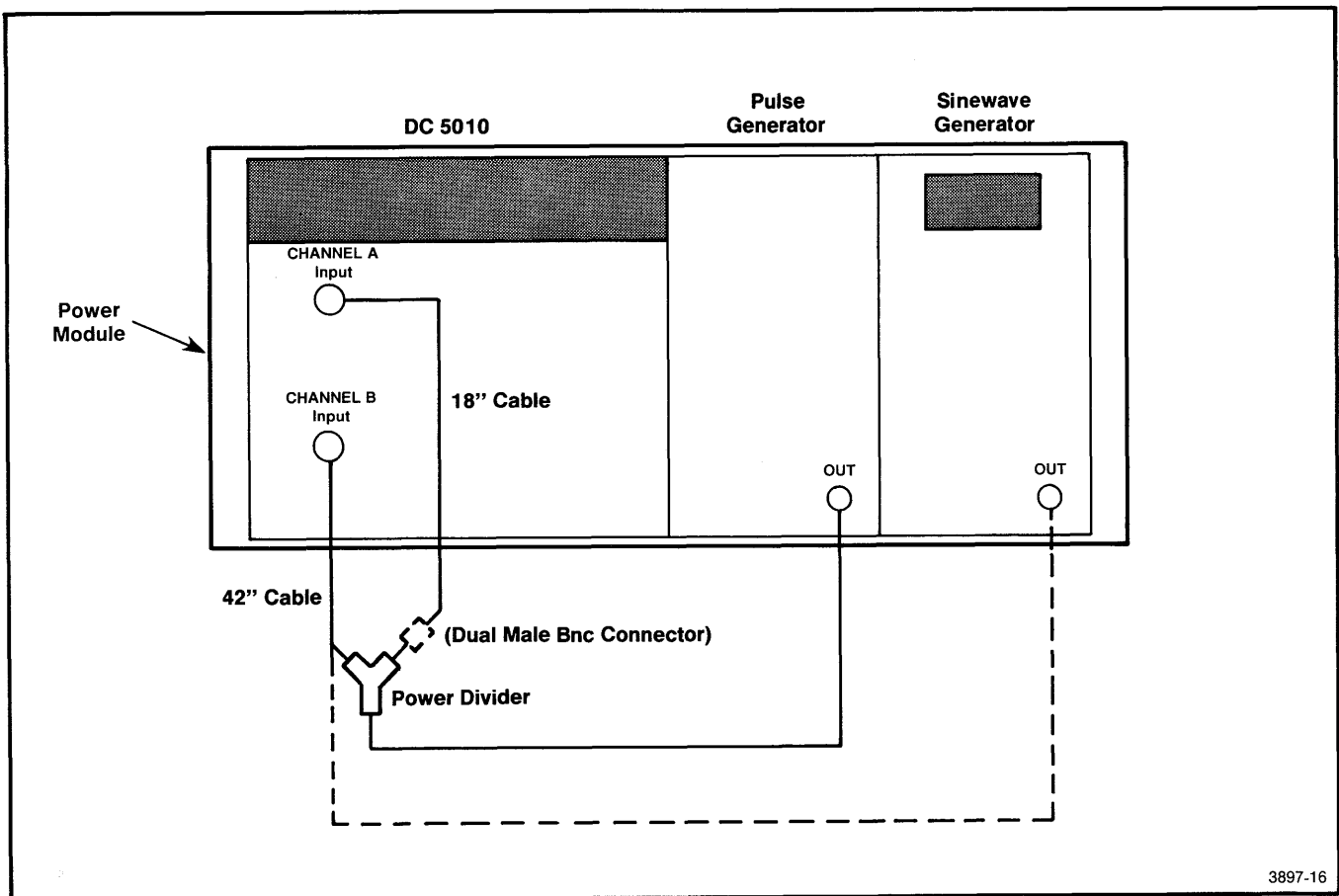


Fig. 4-6. Performance Check setup for step 15.

Calibration—DC 5010
Performance Check Procedure

v. Adjust the pulse generator Period Variable until the DC 5010 display readout indicates 67.XXX MHz (the last three digits can vary due to source instability).

w. Press to light the DC 5010 TIME A → B button.

x. CHECK—that the DC 5010 display readout indicates between 0 and 6.0 ns.

16. Check Probe Compensation

Use the following control settings.

DC 5010

CHANNEL A and
CHANNEL B

ATTEN

X5

TERM

1 M Ω (unlighted)

FREQ A

(lighted)

a. Connect a bnc-to-slide on cable assembly from the DC 5010 PROBE COMP output to the CHANNEL A input.

b. Press the DC 5010 AUTO TRIG button.

c. CHECK—that the DC 5010 display readout indicates between 70.0000 and 170.0000 Hz.

d. Press the DC 5010 WIDTH A function button.

e. CHECK—that the DC 5010 display readout indicates greater than 600.000 μ s and less than 1.3 ms.

f. Press the DC 5010 LEVEL CH A button.

g. CHECK—that the DC 5010 display readout indicates between 2.000 and 3.250 V (50% voltage point; peak voltage equals 4 V to 6.5 V).

17. Check the GPIB Bus Through the Controller

Refer to Talker/Listener sample programs in the Operating instructions.

a. Connect the controller to the TM 5000 power module.

b. Run the sample program for your selected controller using settings and queries commands.

c. CHECK—the DC 5010 display readout and front-panel lighted buttons for returned query data.

This completes the Performance Check.

ADJUSTMENT PROCEDURE

Introduction

Use this Adjustment Procedure to restore the DC 5010 to original performance requirements. This Adjustment Procedure need not be performed unless the instrument fails to meet the Performance Requirements of the Electrical Characteristics listed in the Specification section. If the instrument has undergone repairs, the Adjustment Procedure is recommended. Allow thirty minutes warmup time for operation to specified accuracy (sixty minutes after storage in a high humidity environment).

Satisfactory completion of all adjustment steps in this procedure assures that the instrument will meet the Performance Requirements, providing the instrument is functioning properly.

Test Equipment Required

The test equipment (or equivalent) listed in Table 4-1 is required for adjustment of the DC 5010. Specifications given for the test equipment are the minimum necessary for accurate adjustment. All test equipment is assumed to be correctly calibrated and operating within specifications.

If other test equipment is substituted, calibration setup may need to be altered to meet the requirements of the equipment used.

PRELIMINARY CONTROL SETTINGS

DC 5010

FREQ A	(lighted)
CHANNEL A and CHANNEL B	
ATTEN	X1 (lighted)
SLOPE	+ (unlighted)
COUPL	DC (unlighted)
TERM	50 Ω (lighted)
AVGS	10 ⁶

Preparation

Access to the internal adjustments is achieved most easily when the DC 5010 is connected to the power module with a flexible plug-in extender. Remove the top and side covers of the DC 5010 to reach the adjustments and checks on the Auxiliary, Digital, and Analog boards. Refer to the Adjustment Locations and Setups in the pullout pages at the rear of this manual.

NOTE

Make adjustments at an ambient temperature between +20° C and +30° C.

1. Check the Digital Board +12 V Accuracy ($\pm 2\%$)

a. Set the digital multimeter Function-Range switch to 20 Vdc and connect the Low test lead to the DC 5010 chassis ground. Connect the Volts/ Ω test lead to the Digital board +12 test point.

b. Check that the digital multimeter readout indicates between 11.40 and 12.60 (volts).

2. Check the Digital Board -12.2 V Accuracy ($\pm 2\%$)

a. Remove the Volts/ Ω test lead from the +12 test point and connect it to the -12 test point (Digital board).

b. Check that the digital multimeter readout indicates between -11.40 and -12.60 (volts).

3. Check the Digital Board +5 V Accuracy ($\pm 2\%$)

a. Remove the digital multimeter Volts/ Ω test lead from the -12 test point and connect it to the +5 test point (Digital board).

b. Check that the digital multimeter readout indicates between +4.90 and +5.10 (volts).

c. Remove the Volts/ Ω test lead from the +5 test point.

4. Check the Digital Board +2.5 V (V ref) Accuracy ($\pm 1\%$)

a. Connect the digital multimeter Volts/ Ω test lead to the Digital board Vref test point.

b. Check that the digital multimeter readout indicates between 2.475 and 2.525 (volts).

**Calibration—DC 5010
Adjustment Procedure**

5. Check the Analog Board +5 V Accuracy ($\pm 2\%$)

a. Remove the digital multimeter Volts/ Ω test lead from the Vref test point and connect it to the +5 test point (Analog board).

b. Check that the digital multimeter readout indicates between 4.90 and 5.150 (volts).

6. Check the Analog Board +12 V Accuracy ($\pm 2\%$)

a. Remove the digital multimeter Volts/ Ω test lead from the +5 test point and connect to the +12 test point (Analog board).

b. Check that the digital multimeter readout indicates between 11.76 and 12.24 (volts).

7. Check the Analog Board -5 V Accuracy ($\pm 5\%$)

a. Remove the digital multimeter Volts/ Ω test lead from the +12 test point and connect it to the -5 test point (Analog board).

b. Check that the digital multimeter readout indicates between -4.75 and -5.25 (volts).

c. Remove the test lead connections.

8. Adjust the Standard Timebase Accuracy, C1521, Osc Adj

a. Connect a coaxial cable from the 1 MHz Frequency Standard to the DC 5010 CHANNEL A input.

b. Press the DC 5010 AUTO TRIG button.

c. ADJUST—C1521 (through a hole in the back plate) until the DC 5010 readout indicates between 999.99990 and 1.0000005 MHz.

NOTE

This sets the DC 5010 oscillator within one part in 10^7 . It will take approximately one second for the display to update.

9. Adjust the Optional Timebase Accuracy, Y1530

NOTE

The Option 01 Timebase adjustment is made through an access hole in the back of the oven timebase. Y1530 is located on the back side of the Auxiliary board.

a. Connect a coaxial cable from the 1 MHz Frequency Standard to the DC 5010 CHANNEL A input.

b. Set the DC 5010 LEVEL CH A for a stable display readout.

c. ADJUST—Y1530 until the DC 5010 display readout indicates 1.0000000 MHz.

d. Press to light the PERIOD A button.

e. ADJUST—Y1530 until the DC 5010 display readout indicates between 999.99998 and 999.99999.

f. Remove the cable connections from the DC 5010.

10. Adjust R1205, A Off, and R1207, B Off

Refer to Fig. 8-3, adjustment setup, in the pullout pages. Use the following control settings.

DC 5010

CHANNEL A and
CHANNEL B

TERM	1 M Ω (unlighted)
SLOPE	+ (unlighted)
ATTEN	X1 (lighted)
COUPL	AC (unlighted)
FREQ A	(lighted)

Digital Multimeter

Function-Range 2 V

Pulse Generator

Output low level	(cw)
Output high level	(cw)
Pulse Period	Ext Duration
Pulse Duration	Ext

a. Connect the interconnecting cable from the DC 5010 CH A SHAPED OUT to the digital multimeter input using an rf connector-to-banana adapter.

b. Set the DC 5010 LEVEL CH A to display 0 V.

c. ADJUST—R1205 counterclockwise to the point where the digital multimeter display readout changes from approximately 0 V to approximately .2 V.

d. Move the DC 5010 CH A SHAPED OUT connection to the CH B SHAPED OUT.

e. Set the DC 5010 LEVEL CH B to display 0 V.

f. ADJUST—R1207 counterclockwise to the point where the digital multimeter display readout changes from approximately 0 V to approximately .2 V.

g. Disconnect the digital multimeter cable connection.

11. Adjust R1206, B Rng, and R1204, A Rng

Refer to Fig. 8-3, adjustment setup, in the pullout pages.

a. Connect a coaxial cable with 50 Ω termination from the pulse generator output to the digital multimeter input connectors using a bnc-to-banana adapter.

b. Set the DC 5010 CHANNEL A and B COUPL for DC.

c. Adjust the pulse generator Low and High level controls until the display readout (digital multimeter) indicates between 1.900 and 2.000 volts. Note this reading.

d. Move the coaxial cable with the 50 Ω termination from the digital multimeter input to the DC 5010 CHANNEL B input.

e. Reconnect the cable from the DC 5010 CH B SHAPED OUT to the digital multimeter input connectors.

f. Set the DC 5010 LEVEL CH B to display the reading obtained in step 11c (within 4 mV).

g. ADJUST—R1206 to the point where the digital multimeter display readout changes from approximately 0 V to approximately .2 V.

h. Move the coaxial cable with 50 Ω termination from the DC 5010 CHANNEL B input to the CHANNEL A input.

i. Set the DC 5010 LEVEL CH A to display the reading obtained in step 11c (within 4 mV).

j. ADJUST—R1204 to the point where the digital multimeter display readout changes from approximately 0 V to approximately .2 V.

12. Adjust AT1505 (Channel A) and AT1533 (Channel B), Attenuator Compensation

Refer to Fig. 8-4, adjustment setup, in the pullout pages. Use the following control settings.

DC 5010

CHANNEL A and
CHANNEL B

TERM	1 M Ω (unlighted)
SLOPE	+ (unlighted)
ATTEN	X5 (unlighted)
COUPL	AC (lighted)
PROBE COMP	(lighted)
FILTER	(lighted)

Function Generator

Frequency Hz	1
Multiplier	10 ³
Function	Squarewave
Offset	(midrange)
Output	5 V p-to-p (Amplitude)

a. Connect a 50 Ω terminator and X2 attenuator from the function generator output through a coaxial cable to the DC 5010 CHANNEL A input.

b. Press the DC 5010 PROBE COMP button.

c. ADJUST—the lower adjustment on AT1505 until the digit on the far left side of the DC 5010 display just changes from a steady 1 to a 0. The Channel A X5 attenuation is now compensated.

d. Move the DC 5010 CHANNEL A input connection to the CHANNEL B input and again press the PROBE COMP button.

**Calibration—DC 5010
Adjustment Procedure**

e. ADJUST—the lower adjustment on AT1533 until the DC 5010 digit on the far right side of the display just changes from a steady 1 to a 0. The Channel B X5 attenuation is now compensated.

f. Remove all cable connections.

13. Adjust AT1505 (Channel A) and AT1533 (Channel B), Attenuator Input Capacitance.

Function Generator

Output cw (max amplitude)

a. Compensate a X5 test probe to the DC 5010 CHANNEL A input and set for X1 attenuation. Refer to Probe Compensation in the Operating Instructions of this manual.

b. After the probe has been properly compensated, connect the probe tip to the function generator output using a probe tip-to-bnc connector.

c. Set the DC 5010 CHANNEL A ATTEN to X5 (lighted button) and press to light the PROBE COMP button.

d. ADJUST—the upper adjustment on AT1505, located on the Analog board, until the digit located on the far left side of the DC 5010 display just changes from a steady 1 to a 0. The X5 input capacitance is now equal to the X1 input capacitance.

e. Remove the test probe from the CHANNEL A input and the function generator. Then Compensate the probe (see step 13a) to the DC 5010 CHANNEL B X1 attenuator.

f. Reconnect the probe tip to the function generator output.

g. Set the DC 5010 CHANNEL B ATTEN to $\times 5$ (lighted) and press the PROBE COMP button.

h. ADJUST—the upper adjustment on AT1533, located on the Analog board until the digit on the far right side of the display just changes from a steady 1 to a 0. The Channel B $\times 5$ attenuation is now compensated.

14. Adjust R1142 and R1143, ECL Threshold Reference Level.

NOTE

This procedure should only be performed if U1000, U1001, U1011, U1022, or U1110 have been replaced.

DC 5010

CHANNEL A and
CHANNEL B

TERM	50 Ω
ATTEN	X1
SLOPE	+
COUPLING	DC

a. Pre-set both variable resistors to mid-range (R1142 & R1143).

NOTE

R1142 and R1143 are located on the Analog board (A12) at location 3-D.

b. Set the DC 5010 to TIME MAN.

c. Push MEASUREMENT START/STOP in.

d. ADJUST—R1142 until the instrument counts.

e. Connect a coaxial cable from the 1 MHz frequency standard output to the DC 5010 CHANNEL A input. Adjust for a 100 mV signal.

f. Go to FREQ A mode and push in AUTO TRIG.

g. Check that the instrument counts correctly. Note that R1143 may need adjustment for proper counting. Remove the coaxial cable.

h. Connect a coaxial cable and X10 attenuator from the Signal Generator (SG 504) to the CHANNEL A input.

i. Adjust the Signal Generator for a 350 MHz, 70 mV peak-to-peak signal.

j. ADJUST—R1143 clock-wise and counter-clockwise; noting the two extremes where the instrument still counts. Center R1143 between the extremes in that range.

o. Adjust the signal generator for a 10 MHz, 1 V (RMS) signal, and push in AUTO TRIG.

k. Repeat the procedure of part j., except for R1142.

p. ADJUST—R1143 (staying within the set range) to get a correct and stable readout display.

l. Go to RATIO B/A mode.

This completes the Adjustment Procedure.

m. Move the coaxial cable to the CHANNEL B input.

n. Connect a coaxial cable from a second signal generator (SG 503) to the CHANNEL A input.

MAINTENANCE

Static-Sensitive Components

CAUTION

Static discharge may damage semiconductor components in this instrument.

This instrument contains electrical components that are susceptible to damage from static discharge. See Table 5-1 for relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Observe the following precautions to avoid damage:

1. Minimize handling of static-sensitive components.
2. Transport and store static-sensitive components or assemblies in their original containers, on a metal rail, or on conductive foam. Label any package that contains static-sensitive assemblies or components.
3. Discharge the static voltage from your body by wearing a wrist strap while handling these components. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Keep the component leads shorted together whenever possible.
6. Pick up components by the body, never by the leads.
7. Do not slide the components over any surface.

8. Avoid handling components in areas that have a floor or work surface covering capable of generating a static charge.

9. Use a soldering iron that is connected to earth ground.

10. Use only special antistatic suction type or wick type desoldering tools.

Test Equipment

Before using any test equipment to make measurements on static-sensitive components or assemblies, be certain that any voltage or current supplied by the test equipment does not exceed the limits of the component to be tested.

Table 5-1
RELATIVE SUSCEPTIBILITY
TO STATIC DISCHARGE DAMAGE

Semiconductor Classes	Relative Susceptibility Levels ^a
MOS or CMOS microcircuits or discretes, or linear microcircuits with MOS inputs. (Most Sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFETs	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (Least Sensitive)	9

^a Voltage equivalent for levels:

1 = 100 to 500 V 4 = 500 V 7 = 400 to 1000 V(est.)
 2 = 200 to 500 V 5 = 400 to 600 V 8 = 900 V
 3 = 250 V 6 = 600 to 800 V 9 = 1200 V

(Voltage discharged from a 100 pF capacitor through a resistance of 100 Ω.)

Circuit Board Removal and Replacement

Qualified service personnel will find the DC 5010 instrument cover and board removal quite simple using the following procedure. Refer to Fig. 5-1 and the Parts Location Grids in the pullout pages.

1. Remove the two side covers (four 1/4 turn fasteners).
2. Remove the top and back covers (may be easily removed as a single unit).
 - a. Remove the top cover screws (2).
 - b. Remove the back cover 3/16" hex. bullet connectors (2). Remove the screw that secures the GPIB board to the back cover.
 - c. Carefully pull the covers up and back to remove.
3. To remove the Digital board and GPIB board (removed as a single unit).
 - a. Repeat steps 1 and 2 above.
 - b. Remove the bottom cover screw that secures the Digital board.
 - c. Disconnect the connector, P1611 (J1611), from the Auxiliary board.
 - d. Carefully remove the Digital and interconnected GPIB boards.
4. To remove the GPIB board from the Digital board.
 - a. Remove the screws (2) that secure the GPIB board to the Digital board.
 - b. Separate the two boards taking care not to damage the interconnector pins.
5. To remove the Analog board or the Auxiliary board (these boards are interconnected and must be removed together).
 - a. Repeat steps 1 and 2 above.
 - b. Remove the 9/16" nuts (2) from the front-panel Channel A and B bnc input connectors.
 - c. Remove the bottom cover screws (2) securing both the Analog and Auxiliary boards.

- d. Disconnect the two connectors, P1201 (J1201) and P1130 (J1130), from the Analog board.
- e. Disconnect the connectors, P1500 (J1500) and P1611 (J1611), from the Auxiliary board.
- f. Carefully pull the interconnected boards away from the connector (front panel back) using a gentle up and down rocking motion. Allow sufficient clearance for the input connectors through the front panel.
- g. Gently pull the two boards apart, taking care not to damage the interface connector pins. Often it is easier to begin at one end of the board and separate the connectors one at a time.

NOTE

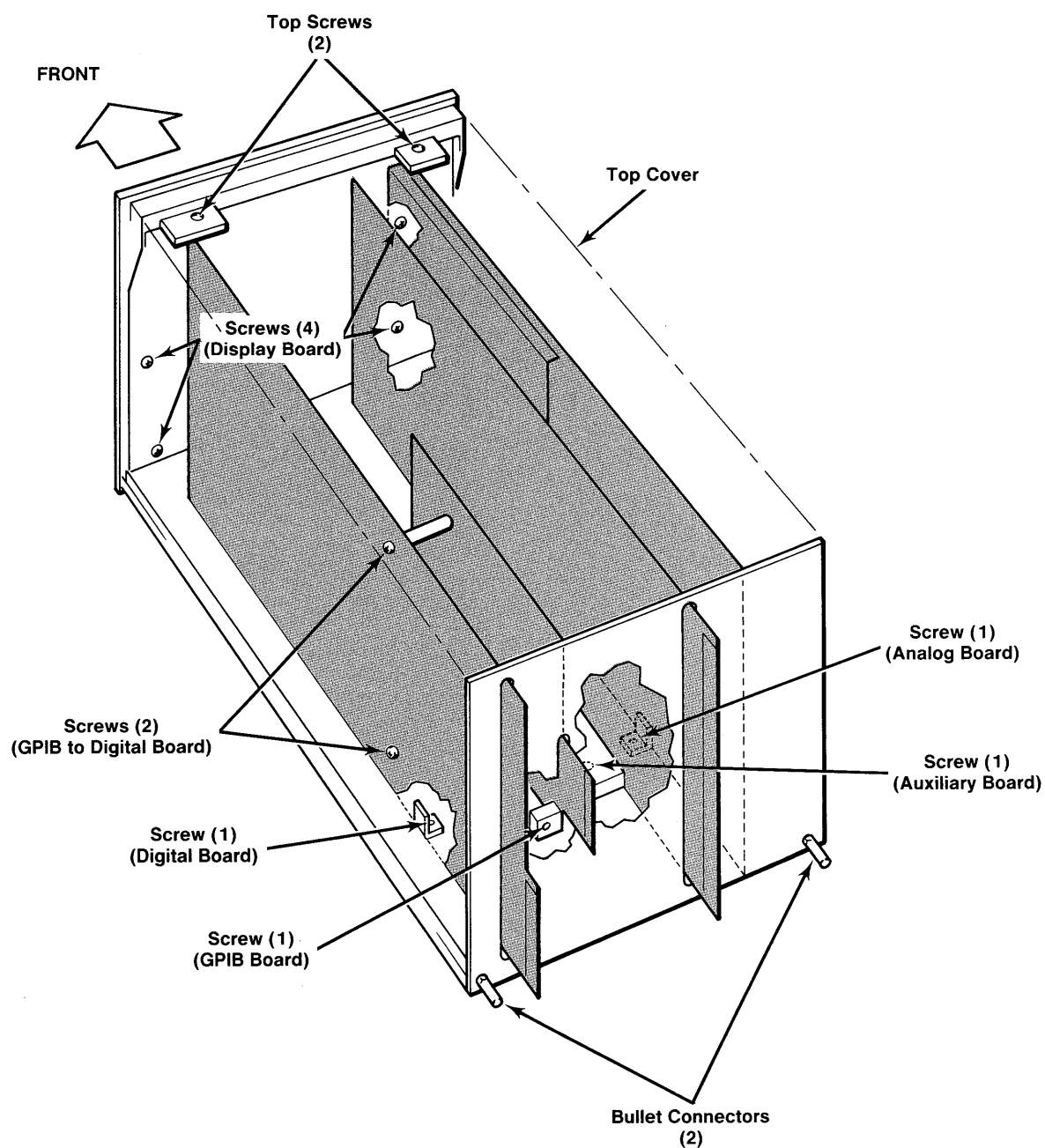
With the Analog board out of the instrument, the Channel A and B bnc connectors are subject to damage. Care should be taken to prevent breaking the bnc solder connection.

6. To remove the Display board. (Use the following to access the seven-segment LEDS and annunciator LEDS)
 - a. Repeat steps 1 through 5 above.
 - b. Disconnect the single-pin connector, P1321.
 - c. Remove the screws (4) that secure the Display board to the front panel (back).
 - d. Carefully remove the Display board, pulling up and away from the bottom and lifting out.
7. To replace the circuit boards, reverse the above procedure.

Magnetic Latch Relays

To prevent damage to these relays, do not remove them from the Analog circuit board unless absolutely necessary. If the relay contacts become noisy or the relay fails to operate, remove the relay from the circuit board. The relays may be individually removed. Remove the two relay hold down screws located on the rear of the Analog board and carefully remove the relay.

Clean the circuit board contacts with a small brush and isopropyl alcohol. Do not use any solvent that may attack polycarbonates such as hydrocarbon chlorides, ketones, esters, etc. Do not use a cotton swab as small cotton filaments may remain on the contact area.



3897-17

Fig. 5-1. Circuit boards removal and replacement.

Clean the contact fingers on the relay armature by lightly brushing the contacts with a brush dipped in isopropyl alcohol.

To remove the relay armature from the relay, obtain a wire or tool with a diameter less than 0.040 inch, such as a paper clip. Before removing the armature, mark the orientation of the armature to the housing. Orientation is important for proper operation. Place the tool in the slot on the side of the housing and gently lift the relay armature. (See Fig. 5-2.)

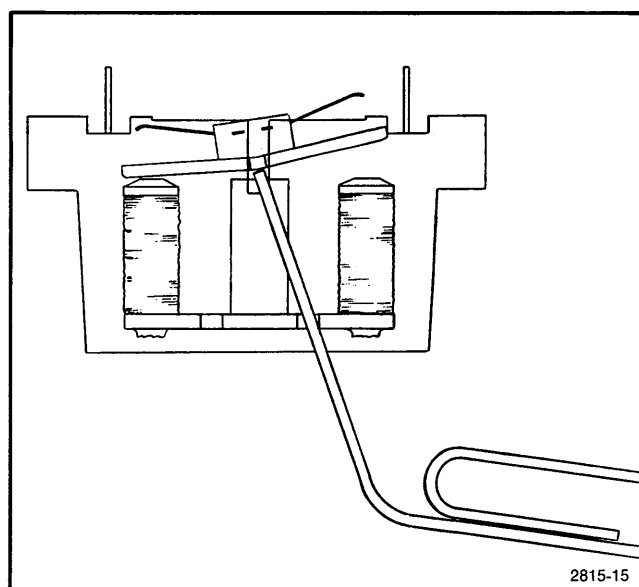


Fig. 5-2. Method of removing magnetic latch relay armature.

Clean the interior of the relay, around the pole pieces, with isopropyl alcohol. The interior of the relay must be completely dry before reinstalling the armature. Use air to dry excess alcohol from the housing.

NOTE

Do not spray contact cleaners of any type on the relays or the board contacts. Any foreign material, including lubricants, can cause faulty operation.

Cleaning Instructions

This instrument should be cleaned only as often as operating conditions require. Accumulation of dirt on components acts as an insulating blanket and prevents efficient heat dissipation that can cause overheating and component breakdown.

CAUTION

Avoid the use of chemical cleaning agents that might leave a film or damage the plastic material used in this instrument. Use a nonresidue type of cleaner; preferably, isopropyl alcohol or totally denatured ethyl alcohol. Before using any other type of cleaner, consult your Tektronix Service Center or representative.

Exterior. Loose dust accumulated on the front panel can be removed with a soft cloth or a small brush. Dirt that remains can be removed with a soft cloth dampened with a mild detergent and water solution. Abrasive cleaners should not be used.

Interior. Dust in the interior of the instrument should be removed occasionally, due to its electrical conductivity under high humidity conditions. The best way to clean the interior is to blow off the accumulated dust with dry, low pressure air then use a soft brush. If further cleaning is required, use a mild detergent and water solution, flushing well with clean water.

CAUTION

Do not clean the circuit board with water, air, or any solvent, unless the relays are removed first. Any dirt forced or carried under the contacts can cause intermittent operation. Circuit boards and components must be dry before applying power to prevent damage from electrical arcing.

Drying can be accomplished with dry, low-pressure air or by placing in an oven at 40°C to 60°C for approximately four hours.

After making minor board repairs, cleaning is best accomplished by carefully flaking or chipping the solder flux from the repaired area.

Isopropyl alcohol can be used to clean major repairs to the circuit board; however, flush the board well with clean, isopropyl alcohol. Make certain that resin or dirt is carefully removed from the board.

Obtaining Replacement Parts

Electrical and mechanical parts can be obtained through your local Tektronix Field Office or representative. However, many of the standard electronic components can be ob-

tained from a local commercial source. Before purchasing or ordering parts from a source other than Tektronix, Inc., check the Replaceable Electrical Parts list for the proper value, rating, tolerance, and description.

Ordering Parts

When ordering replacement parts from Tektronix, Inc., it is important to include all of the following information.

1. Instrument type (include modification or option numbers).
2. Instrument serial number.
3. A description of the part (if electrical, include the component number).
4. Tektronix part number.

Soldering Techniques

WARNING

To avoid electric shock hazard, disconnect the instrument from the power source before soldering.

The reliability and accuracy of this instrument can be maintained only if proper soldering techniques are used when repairing or replacing parts. General soldering techniques which apply to maintenance of any precision electronic equipment should be used when working on this instrument. Use only 60/40 rosin-core, electronic grade solder. The choice of soldering iron is determined by the repair to be made.

CAUTION

The Analog board in the DC 5010 is a multilayer type board with a conductive path laminated between the top and bottom board layers. All soldering on this board should be done with extreme care to prevent breaking the connections to this conductive path. Only experienced maintenance personnel should attempt to repair this board. Do not allow solder or solder flux to flow under printed circuit board relays. The printed circuit board is part of the relay contacts; intermittent relay operation can occur if the contacts are contaminated.

When soldering on circuit boards or small wiring, use only a 15 watt, pencil type soldering iron. A higher wattage soldering iron can cause the etched circuit wiring to separate from the board base material and melt the insulation from small wiring. Always keep the soldering iron tip properly tinned to ensure the best heat transfer to the solder joint. Apply only enough heat to remove the component or to make a good solder joint. To protect heat sensitive components, hold the component lead with a pair of long-nose pliers between the component body and the solder joint. Use a solder removing wick to remove excess solder from connections or to clean circuit board pads.

To remove in-line integrated circuits use an extracting tool. This tool is available from Tektronix, Inc.; order Tektronix Part Number 003-0619-00. If an extracting tool is not available, use care to avoid damaging the pins. Pull slowly and evenly on both ends of the integrated circuit. Try to avoid disengaging one end before the other end.

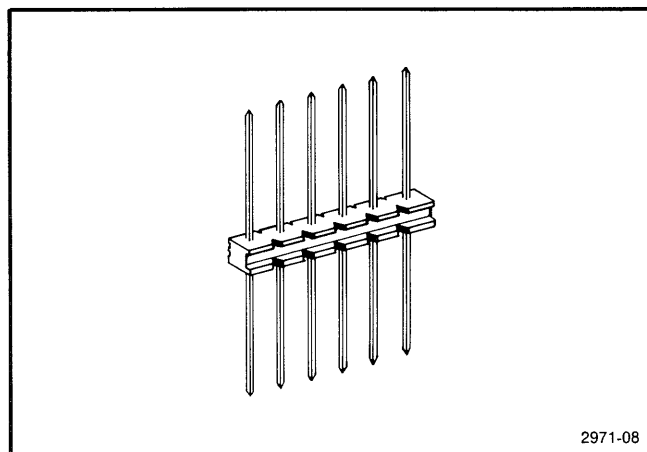
Interconnecting Pins

Several methods of interconnection, including square pin, are used to electrically connect the circuit boards with the other boards and components.

Several types of mating connectors are used for these interconnecting pins. The following information provides the removal and replacement procedure for the various interconnecting methods.

Square Pin Assemblies

See Fig. 5-3. These pins are of various lengths. They are attached to each other with a plastic strip. To remove them simply unsolder from the circuit board.



2971-08

Fig. 5-3. Typical square pin assembly.

Bottom Entry and Side Entry Circuit Board Pin Sockets

To remove or replace these sockets unsolder the pins from the circuit board. Use a vacuum or other type desoldering tool to remove excess solder. Use caution to prevent circuit board damage. See Fig. 5-4 for bottom entry socket example.

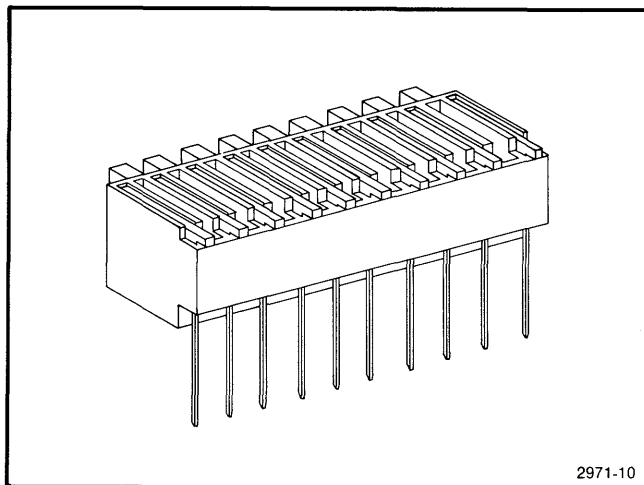


Fig. 5-4. Bottom entry circuit board pin socket.

Multipin Connectors

The pin connectors used to connect the wires to the interconnecting pins are clamped to the ends of the wires. To replace damaged multipin connectors, remove the old pin connector from the holder. Do this by inserting a scribe between the connector and the holder and prying the connector from the holder. Clamp the replacement connector to the wire. Reinstall the connector in the holder.

If the individual end lead pin connectors are removed from the plastic holder, note the order of the individual wires for correct replacement in the holder. For proper replacement see Fig. 5-5.

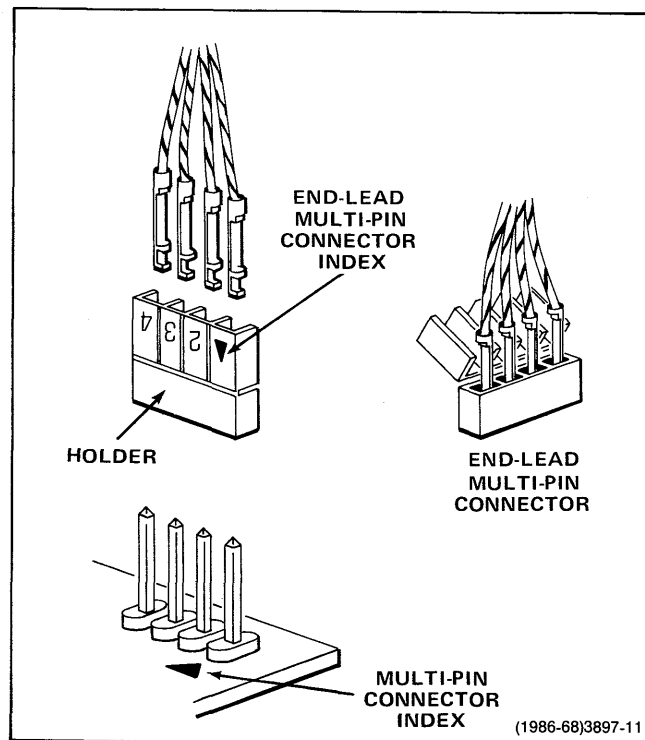


Fig. 5-5. Orientation and disassembly of multipin connectors.

REAR INTERFACE CONNECTORS

Introduction

Refer to Fig. 5-6 for the following.

A slot between pins 21 and 22 on the rear connector identifies this instrument as a member of the TM 5000 counter family. Insert a barrier in the corresponding position of the power module jack to prevent noncompatible plug-ins from being used in that compartment. Consult the power module manual for further information.

Functions Available at Right Rear Interface Connector (P1600)

Pin 14A. External Clock Input—This input allows an external 1, 5, or 10 MHz frequency standard to be used in place of the internal timebase. The input is ac coupled and has a 1 k Ω input resistance. The peak-to-peak input voltage required is ≥ 0.5 V.

Pin 14B. Prescale—When this available line is held low, the counter automatically adjusts the displayed answer for use with a divide-by-16 prescaler in FREQ A, PERIOD A, RATIO B/A, and TOTALIZE A modes (≤ 1 TTL load).

Pin 15A. 10 MHz Clock Out Ground—This terminal is the ground return for the clock input-output signals.

Pin 15B. 10 MHz Clock Out—This available output line will drive one TTL load. This line is not intended to drive large capacitance loads and cable length should be kept to a minimum.

Pin 26A. Reset Input—When this line is set low, the current measurement process is aborted for all selected functions and causes all digits in the display to read 8.8.8.8.8.8.8.8. All eight annunciators (and push buttons) are also illuminated. When this line is set high, a new measurement process is initiated for the selected FUNCTION and operating conditions. (CMOS $V_{IL} \leq 1.5$ V and $V_{IH} \geq 3.5$ V with a minimum pulse width of approximately 10 ms.) When not used, the line is in the high state.

Pin 27A. Arming Input—This terminal is normally at a TTL high level. When pulled to a TTL low state with a TTL signal or transistor collector, the counter is

OUTPUT OR INPUT	PIN B		PIN A	OUTPUT OR INPUT
	28	BARRIER SLOT	28	ARMING INPUT GROUND
	27		27	ARMING INPUT
	26		26	RESET INPUT
	25		25	
	24		24	
	23		23	
	22		22	
	21		21	
	20	TM 5000 BARRIER SLOT	20	
	19		19	
	18		18	
	17		17	
	16		16	
10MHz CLOCK OUT	15		15	10MHz CLOCK OUT GROUND
PRESCALE	14		14	EXTERNAL CLOCK INPUT
	13		13	
+26V DC	12		12	+26V DC
COLLECTOR LEAD OF PNP SERIES PASS	11		11	BASE LEAD OF PNP SERIES PASS
	10		10	EMITTER LEAD OF PNP SERIES PASS
± 26 V COMMON	9		9	± 26 V COMMON
-26V DC	8		8	-26V DC
COLLECTOR LEAD OF NPN SERIES PASS	7	REAR VIEW OF PLUG-IN	7	EMITTER LEAD OF NPN SERIES PASS
	6		6	BASE LEAD OF NPN SERIES PASS
	5		5	
+8V COMMON	4		4	+8V COMMON
+8V COMMON	3		3	+8V COMMON
+8V DC	2		2	+8V DC
	1		1	

3897-18

Fig. 5-6. Right rear interface connector assignments.

prevented from making a measurement until the input goes to a TTL high state. When this input is routed to the rear interface it is dc coupled to the front panel arm signal. ($V_H \geq 2.4$ V, $V_L \leq 0.4$ V approximately 2 TTL loads).

Pin 28A. Arming Input Ground—This terminal is the ground return for the rear interface arming input signal.

Functions Available at Left Rear Interface Connector (P1820). Refer to Fig. 5-7 for connector assignments.

GPIO Rear Interface Connector (P1001)

Refer to Fig. 5-8 for the following connector assignments.

Functions Available at GPIO Connector (located on the GPIO board, A14)

- Pins 1 through 8 GPIO data bus lines—Digital data input-output lines (one through eight).
- Pin 11 EOI — End or Identify.
- Pin 12 IFC — Interface Clear.
- Pin 13 DAV — Data Valid.
- Pin 14 SRQ — Service Request.
- Pin 15 NRFD — Not Ready For Data.
- Pin 16 ATN — Attention.
- Pin 17 NDAC — Not Data Accepted.
- Pin 18 REN — Remote Enable.

OUTPUT OR INPUT	PIN B		PIN A	OUTPUT OR INPUT
+26V DC	12	TM 5000 BARRIER SLOT	12	+26V DC
COLLECTOR LEAD OF PNP SERIES PASS	11		11	BASE LEAD OF PNP SERIES PASS
	10		10	EMITTER LEAD OF PNP SERIES PASS
±26V COMMON	9		9	±26V COMMON
-26V DC	8		8	-26V DC
COLLECTOR LEAD OF NPN SERIES PASS	7	REAR VIEW OF PLUG-IN	7	EMITTER LEAD OF NPN SERIES PASS
	6		6	BASE LEAD OF NPN SERIES PASS
	5		5	
+8V COMMON	4		4	+8V COMMON
+8V COMMON	3		3	+8V COMMON
+8V DC	2		2	+8V DC
	1		1	

3897-19

Fig. 5-7. Left rear interface connector assignments.

OUTPUT OR INPUT	PIN		PIN	OUTPUT OR INPUT
D101	1		2	D105
D102	3		4	D106
D103	5		6	D107
D104	7		8	D108
CE *	9		10	TE *
EOI	11		12	IFC
DAV	13		14	SRQ
NRFD	15		16	ATN
NDAC	17		18	REN
NC	19		20	NC

* NOT USED IN DC 5010

3897-20

Fig. 5-8. Rear GPIO interface connector assignments.

BUS ADDRESS AND MESSAGE TERMINATOR SWITCHES

Setting the GPIO Address Switches

A single bank of six switches is located on the Digital board. See Fig. 5-9.

NOTE

The address switch located on the GPIO board does not function.

The lower five of these switches (A5 through A1) set the desired value of the lower five bits of the listen and talk addresses for the DC 5010. The decimal value of these switches is called the instrument's primary address (see Table 5-2) which corresponds to the listen and talk addresses.

The DC 5010 microprocessor reads these switches at each power-up event and displays the primary address in the front panel display window each time the INST ID push button is pressed. If the termination switch is set to EOI/LF (logic 1), the GPIO address is displayed with a decimal point. If it is set to EOI ONLY (logic 0) the GPIO address number is displayed.

The DC 5010 is shipped from the factory with the switch set to address 20 and EOI ONLY.

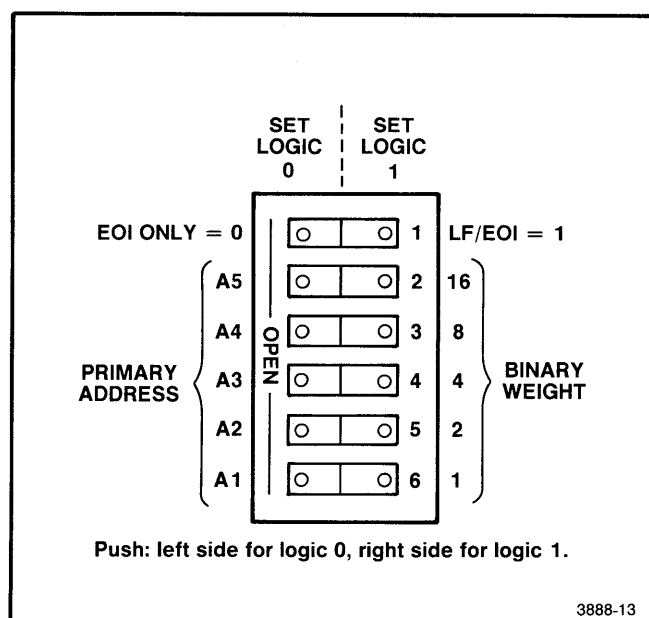


Fig. 5-9. Bus address and message terminator switches.

The address byte sent by the controller is actually eight bits wide. Bits 5 through 1 are for the primary address set according to Table 5-2, while bits 7 and 6 determine whether the byte is a listen address ($32 + \text{primary address}$) or a talk address ($64 + \text{primary address}$). Secondary address bytes (where bits 7 and 6 are both a logical 1) are not used by the DC 5010, so they are ignored.

Before power-up, set switches A5 through A1 as desired. Do not set primary address 0 when using TEKTRONIX 4050-Series controllers. They reserve primary address 0 for themselves. Setting the primary address to 31 logically removes the DC 5010 from the GPIB. It does not respond to any GPIB addresses or commands and remains both unlistened (UNL) and untalked (UNT).

Setting the Input/Output Message Terminator Switch

The top switch (number 1), illustrated in Fig. 5-9, is used to select the terminator of messages on the bus. If LF/EOI is selected, the DC 5010 interprets either the line feed (LF) character or the assertion of EOI concurrently with a data byte as the end of an input message string. If EOI ONLY is selected, the DC 5010 interprets the byte sent with EOI asserted as the end of an input message string.

Table 5-2
IEEE 488 (GPIB)
PRIMARY ADDRESSES

Switches					Primary Address
A5	A4	A3	A2	A1	
0	0	0	0	0	0
0	0	0	0	1	1
0	0	0	1	0	2
0	0	0	1	1	3
0	0	1	0	0	4
0	0	1	0	1	5
0	0	1	1	0	6
0	0	1	1	1	7
0	1	0	0	0	8
0	1	0	0	1	9
0	1	0	1	0	10
0	1	0	1	1	11
0	1	1	0	0	12
0	1	1	0	1	13
0	1	1	1	0	14
0	1	1	1	1	15
1	0	0	0	0	16
1	0	0	0	1	17
1	0	0	1	0	18
1	0	0	1	1	19
1	0	1	0	0	20
1	0	1	0	1	21
1	0	1	1	0	22
1	0	1	1	1	23
1	1	0	0	0	24
1	1	0	0	1	25
1	1	0	1	0	26
1	1	0	1	1	27
1	1	1	0	0	28
1	1	1	0	1	29
1	1	1	1	0	30
1	1	1	1	1	31

This switch also selects the output message terminator from the DC 5010. If set to LF/EOI, the DC 5010 adds the carriage return (CR) and line feed (LF) characters, with EOI asserted along with LF, after the last byte in the output message string. If set to EOI ONLY, the DC 5010 asserts EOI concurrently with the last byte of the output message string.

DIAGNOSTICS

Introduction

The following information is intended to aid in the diagnosis and repair of a malfunctioning instrument. With power-on Self Test, signature analysis checks, and other troubleshooting data, the qualified service personnel will be able to verify proper operation or detect malfunction in this instrument.

Not all of the instrument faults may be isolated by this information or indicated by the instrument's built-in self test features. The service personnel should then refer to the Theory of Operation section, in this manual for a better understanding of the circuit details.

Equipment Required

The recommended diagnostic tests require the following equipment or equivalent.

Data analyzer.	TEKTRONIX type SA 501 or type 308 Data Analyzer (for signature analysis)
Digital counter.	TEKTRONIX type DC 503A (for time-base frequency checks)
Digital multimeter.	TEKTRONIX type DM 501A (for checking power supplies)

Also refer to the equipment list in the Calibration section of this manual for suggestions on oscilloscope systems, probes, adapters, terminations and other equipment that may be useful for troubleshooting purposes.

Adjustment and Test Point Locations

When locating adjustable components and test points, refer to the Adjustment and Setups Location in the pullout pages of this manual.

Self Test

The DC 5010 has three modes of self test. The automatic test sequence at power on, the TEST function selected by the front panel FUNCTION switch and the TEST function via the GPIB.

The automatic test sequence at power-on (Power On Self Test) is initiated each time the power is applied to the instrument. The microprocessor sequences through special data patterns to test the operation of the circuits in the instrument. At power-on, after the microprocessor reset line has been released, the following tests are performed:

1. The display (time slot generator, schematic 10) is reset to the most significant digit (digit to extreme left) and a 0 readout is displayed.

2. The RAM is tested by writing a known bit pattern into the RAM and reading it back. Each byte in the RAM is verified. If any byte does not verify, the RAM test error code is displayed on the front panel and the test sequence stops. The patterns written are FF, AA, 55, 00 (hexidecimal) in succession leaving the RAM cleared when the test is finished. If this test is not successfully completed, the proper error code is displayed and the self test sequence stops.

3. The ROM's are checked for both placement and also proper checksums. If any of these tests fail, the power on self test sequence is stopped and the proper error code is displayed.

4. Next, the automatic test sequence sets the instrument gating to the RATIO B/A function.

5. The serial I/O data loop is checked next, by writing out a data pattern to the serial-to-parallel shift registers. The data pattern is read back through the parallel-to-serial shift registers. If the data are correct, the power-on sequence continues. If the data are not correct, the error code for this test is displayed and the test sequence stops. This test checks the shift registers and the data path, including the serial clock but does not check the input or output stages of the shift registers or the latch control lines. Troubleshooting of the serial I/O loop is best accomplished using signature analysis.

6. The next test is the counter integrity test. This test first resets the instrument's Channel A and Channel B accumulators by pulsing the MR (master reset) line. It then checks each of the tested counter stages to verify that all bits are reset. If any bits are not reset, the proper error code is displayed and the test sequence stops. Next, the $\overline{\text{GATE}}$ signal, (schematic 3) is asserted. The instrument then inputs counts to the accumulators. These counts are generated by changing the trigger levels for both Channel A and Channel B using the D/A converters. The D/A converter level changes (cycles) from its current setting to +2.0 V then to -2.0 V and back to +2.0 V. This cycle represents one count if the Channel A and Channel B input voltages are within this voltage range and the ARM signal, (schematic 6) is in the high state.

After each cycle or set of cycles, the accumulators are read and checked to see if the proper count has been

reached. If a count greater than or equal to the proper count has not been accumulated, the error code for that accumulator stage is displayed and the self test sequence stops.

An improper count might occur because of a bad counter chip, a bad readout chip, or a disconnected cable.

NOTE

The signal path starts at the D/A converters and the cycle must pass through the amplifiers, gating, and the accumulators. A first bit error (320, 330) may indicate an amplifier, FET or Schmitt error.

7. If the counter integrity test fails for any of the described reasons, the D/A converters will be set to -2 V . The gating (schematic 3), remains in the RATIO B/A function and by applying a signal, that crosses the -2 V Trigger level settings, to the appropriate channel input, the service personnel can trace this signal through the amplifier, gating, and accumulator circuits. Also refer to Table 8-2 in the pullout pages.

TEST Function

The TEST function from the front panel and over the bus is similar to the Power On Self Test sequence with one exception. The RAM test is not executed, thereby preventing the instrument's settings from being lost while in the TEST function.

TROUBLESHOOTING

The following is a general troubleshooting procedure to use when the instrument malfunctions.

First, verify that the instrument is properly connected to the appropriate power module and that this power module is operable. Then refer to Fig. 8-5, General Troubleshooting Flowchart, in the pullout pages. This flowchart is a guide for qualified service personnel to locate various areas of circuitry, depending on the instrument symptoms. It may also refer the service personnel to the following signature analysis procedure.

SIGNATURE ANALYSIS

Introduction

The DC 5010 was designed to be compatible with two signature analysis methods.

Internal signature analysis—this is a microprocessor driven pattern generator contained in the ROM. This method will only work when the kernel microprocessor and its associated ROM, RAM, and connections are functional.

Kernel signature analysis—this requires the use of an external kernel test service kit (Tektronix part number 067-1007-00). This method allows qualified service personnel to test and isolate problems in the kernel of the instrument.

Internal Signature Analysis

The internal signature analysis mode is entered at power-on by pressing the CHANNEL A TERM button ($50\ \Omega$) as power is applied. This mode will not operate if the instrument fails the power on RAM test. Refer to Figs. 8-6, 8-7, 8-8, and 8-9 in the pullout pages, for the internal signatures setup information for each circuit board.

In the internal signature analysis mode, the serial loop is most easily diagnosed. The START, STOP, and CLOCK edge polarities must be properly set as shown on the appropriate signature diagram. When the instrument is in this mode, all segments and annunciators in the display are lighted, with the extreme left digit brighter than the other digits. The pushbuttons are also lighted.

To exit the Internal Signature Analysis mode, the instrument must be powered down and then powered up.

Kernel Signature Analysis

CAUTION

The Digital board microprocessor, U1301, is removed (observing proper static handling procedures) before making the kernel test.

The kernel signature analysis mode is used to diagnose problems that prevent the microprocessor kernel circuitry from functioning properly. It is used with a signature analyzer to verify signatures in the kernel circuitry.

Make certain the power module power is off when connecting this service kit to the instrument. To make the DC 5010 kernel board connections, the GPIB board (A14) must first be removed (refer to Circuit Boards Removal and Replacement). Then, connect J1002 and J1003 of the Kernel Test board to J1210 and J1211 on the instrument Digital board (A16), respectively, using the cables and square pin adapters provided with the kit. Make sure that the cables do

not get twisted. The GPIB board is attached to the Kernel Test board as shown in Fig. 5-10. Connect the START, STOP, CLOCK, and GROUND connections of the analyzer to the test points as indicated on the appropriate Kernel Signature (Fig. 8-10 and Fig. 8-11) in the pullout pages. Also make sure that the START, STOP, and CLOCK polarities have been properly selected on the analyzer.

In troubleshooting the kernel, the following information may be helpful.

Microprocessor kernel problems in the DC 5010 can be isolated to either the GPIB board (A14) or the Digital board

(A16). This may be accomplished by first removing the GPIB board from the instrument. Then, insert the microprocessor (see the Electrical Parts list for U1510) in the U1510 IC socket on the Digital board. If the problem remains, check the Digital board. Troubleshoot the Digital board with the Kernel Test board and signature analyzer, as shown in Fig. 8-10. If the instrument operates properly, the problem is most likely on the GPIB board. Troubleshoot the GPIB board for kernel problems using the previously described kernel test and referring to Fig. 8-11.

The Kernel Test Service Kit may also be used to extend the GPIB board from the Digital board to troubleshoot components on the Digital board. This may be done by using just the cables and square pin adapters provided in the kit.

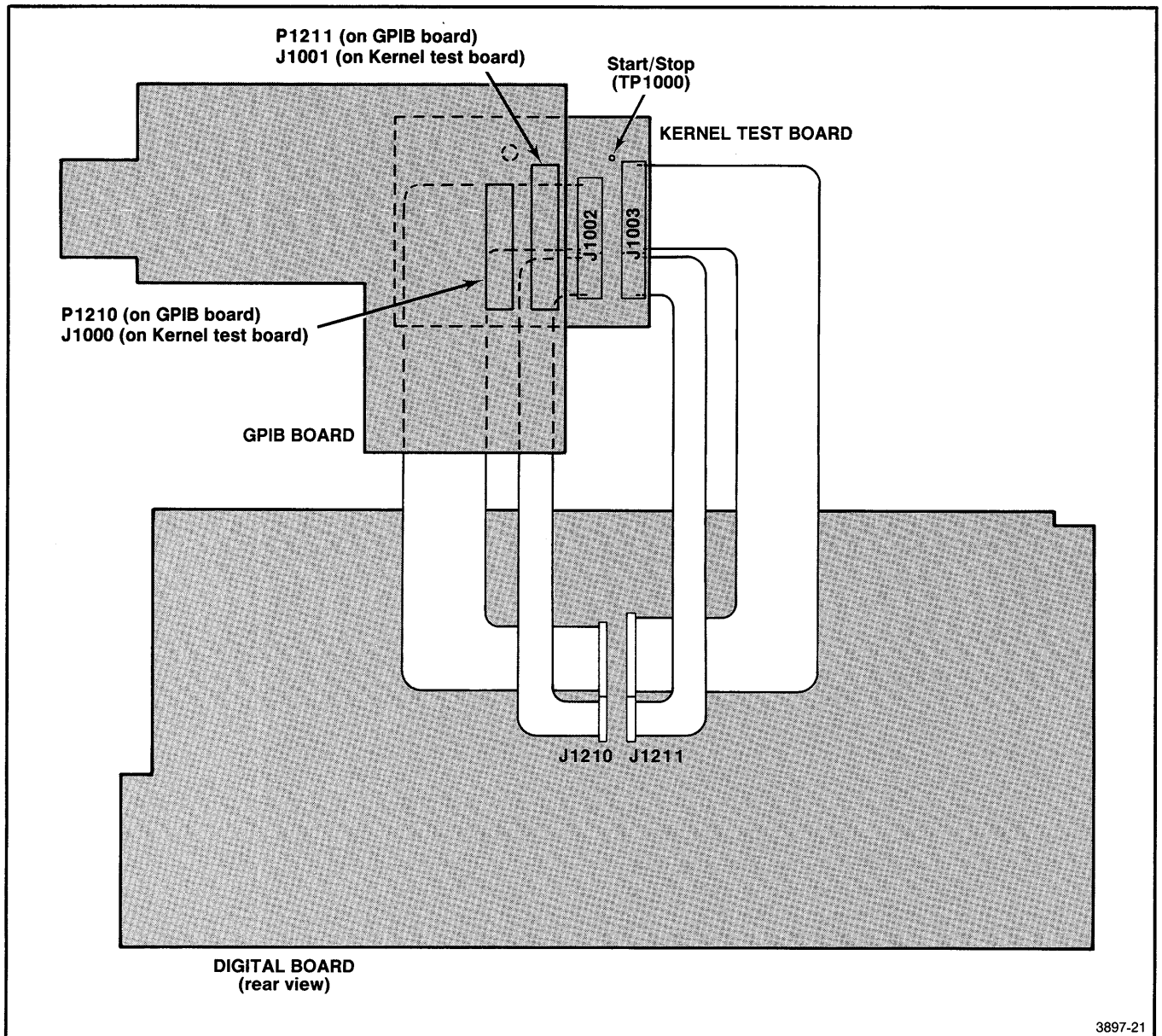


Fig. 5-10. Kernel signature analysis connections.

Two physically adjacent points having the same signature, whether one or both are incorrect, may indicate they are shorted together.

A point with 0000 signature is grounded, or in a low state. A point with the +5 V signature (noted on each signature diagram) may be opened or the driving node may be stuck in the high state. The point might also be shorted to +5 V.

When the malfunction has been identified and corrected, carefully re-insert the Digital board microprocessor, making certain that pin 1 is properly oriented and all pins insert in the socket properly. DO NOT FORCE the pins.

Selected Components (R1307 and R1326)

Refer to diagram 2 (board A12) in the pullout pages for the following.

If IC's U1310 and U1330 (M234 Type) are replaced and the input sensitivity ($50\ \Omega$) is found to exceed 57 mV peak-to-peak at 100 MHz (25°C ambient temperature), the following procedure is recommended.

NOTE

If IC's U1310 and U1330 (M234) should have to be replaced, the input sensitivity is unlikely to vary.


The values of selected resistors, R1307 and R1326 (nominal value of $1.4\ \text{K}\Omega$ each) may be changed to alter the input sensitivity for channels A and B respectively.

If the instrument requires more than a 57 mV peak-to-peak signal to trigger it, the resistance values of R1307 and R1326 will need to increase. The sensitivity will change approximately 10 mV p-p for each 500 ohms of resistance change.

OPTIONS

Your instrument may be equipped with one or more instrument options or optional accessories. A brief description of each instrument option is given below. For further information on instrument options or optional accessories, see your Tektronix Catalog or contact your Tektronix Field Office. If additional options are made available for this instrument, they may be described in a Change Information insert at the back of this manual or in this section.

OPTION 01

Replaces the standard 10 MHz oscillator with a self contained, proportional temperature controlled oven oscillator for increased accuracy and stability. Information relative to Option 01 can be found on schematic , and in the Specification, Calibration, and Theory of Operation sections.

REPLACEABLE ELECTRICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

LIST OF ASSEMBLIES

A list of assemblies can be found at the beginning of the Electrical Parts List. The assemblies are listed in numerical order. When the complete component number of a part is known, this list will identify the assembly in which the part is located.

CROSS INDEX-MFR. CODE NUMBER TO MANUFACTURER

The Mfr. Code Number to Manufacturer index for the Electrical Parts List is located immediately after this page. The Cross Index provides codes, names and addresses of manufacturers of components listed in the Electrical Parts List.

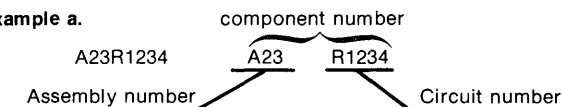
ABBREVIATIONS

Abbreviations conform to American National Standard Y1.1.

COMPONENT NUMBER (column one of the Electrical Parts List)

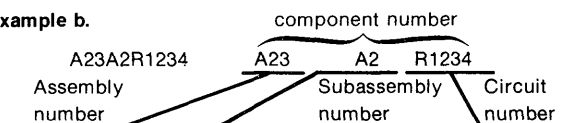
A numbering method has been used to identify assemblies, subassemblies and parts. Examples of this numbering method and typical expansions are illustrated by the following:

Example a.



Read: Resistor 1234 of Assembly 23

Example b.



Read: Resistor 1234 of Subassembly 2 of Assembly 23

Only the circuit number will appear on the diagrams and circuit board illustrations. Each diagram and circuit board illustration is clearly marked with the assembly number. Assembly numbers are also marked on the mechanical exploded views located in the Mechanical Parts List. The component number is obtained by adding the assembly number prefix to the circuit number.

The Electrical Parts List is divided and arranged by assemblies in numerical sequence (e.g., assembly A1 with its subassemblies and parts, precedes assembly A2 with its subassemblies and parts).

Chassis-mounted parts have no assembly number prefix and are located at the end of the Electrical Parts List.

TEKTRONIX PART NO. (column two of the Electrical Parts List)

Indicates part number to be used when ordering replacement part from Tektronix.

SERIAL/MODEL NO. (columns three and four of the Electrical Parts List)

Column three (3) indicates the serial number at which the part was first used. Column four (4) indicates the serial number at which the part was removed. No serial number entered indicates part is good for all serial numbers.

NAME & DESCRIPTION (column five of the Electrical Parts List)

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

MFR. CODE (column six of the Electrical Parts List)

Indicates the code number of the actual manufacturer of the part. (Code to name and address cross reference can be found immediately after this page.)

MFR. PART NUMBER (column seven of the Electrical Parts List)

Indicates actual manufacturers part number.

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip
0001D	G & E MICROCIRCUITS	2000 W 14TH STREET	TEMPE, AZ 85281
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01121	ALLEN-BRADLEY COMPANY	1201 2ND STREET SOUTH	MILWAUKEE, WI 53204
01295	TEXAS INSTRUMENTS, INC., SEMICONDUCTOR GROUP	P O BOX 5012, 13500 N CENTRAL EXPRESSWAY	DALLAS, TX 75222
03508	GENERAL ELECTRIC COMPANY, SEMI-CONDUCTOR PRODUCTS DEPARTMENT	ELECTRONICS PARK	SYRACUSE, NY 13201
03888	KDI PYROFILM CORPORATION	60 S JEFFERSON ROAD	WHIPPANY, NJ 07981
04222	AVX CERAMICS, DIVISION OF AVX CORP.	P O BOX 867, 19TH AVE. SOUTH	MYRTLE BEACH, SC 29577
04713	MOTOROLA, INC., SEMICONDUCTOR PROD. DIV.	5005 E MCDOWELL RD, PO BOX 20923	PHOENIX, AZ 85036
07263	FAIRCHILD SEMICONDUCTOR, A DIV. OF FAIRCHILD CAMERA AND INSTRUMENT CORP.	464 ELLIS STREET	MOUNTAIN VIEW, CA 94042
11532	TELEDYNE RELAYS	3155 W EL SEGUNDO BLVD.	HAWTHORNE, CA 90250
14433	ITT SEMICONDUCTORS	3301 ELECTRONICS WAY P O BOX 3049	WEST PALM BEACH, FL 33402
18324	SIGNETICS CORP.	811 E. ARQUES	SUNNYVALE, CA 94086
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
24546	CORNING GLASS WORKS, ELECTRONIC COMPONENTS DIVISION	550 HIGH STREET	BRADFORD, PA 16701
24931	SPECIALITY CONNECTOR CO., INC.	2620 ENDRESS PLACE	GREENWOOD, IN 46142
27014	NATIONAL SEMICONDUCTOR CORP.	2900 SEMICONDUCTOR DR.	SANTA CLARA, CA 95051
32997	BOURNS, INC., TRIMPOT PRODUCTS DIV.	1200 COLUMBIA AVE.	RIVERSIDE, CA 92507
33096	COLORADO CRYSTAL CORPORATION	2303 W 8TH STREET	LOVELAND, CO 80537
34576	ROCKWELL INTERNATIONAL CORP.		
50434	ELECTRONIC DEVICES DIVISION	3310 MIRALBMA AVE.	ANAHEIM, CA 92803
51642	HEWLETT-PACKARD COMPANY	640 PAGE MILL ROAD	PALO ALTO, CA 94304
51984	CENTRE ENGINEERING INC.	2820 E COLLEGE AVENUE	STATE COLLEGE, PA 16801
51984	NEC AMERICA INC. RADIO AND TRANSMISSION DIV.	2990 TELESTAR CT. SUITE 212	FALLS CHURCH, VA 22042
52262	B AND H ELECTRONICS, INC., DBA MICRO COMPONENTS ASSOCIATES	202 E STEVENS ST., SUITE 6	SANTA ANA, CA 92707
52648	PLESSEY SEMICONDUCTORS	1641 KAISER	IRVINE, CA 92714
53184	XCITON CORPORATION	5 HEMLOCK STREET	LATHAM, NY 12110
55576	SYNERTEX	3050 CORONADO DR	SANTA CLARA, CA 95051
55680	NICHICON/AMERICA/CORP.	6435 N PROESEL AVENUE	CHICAGO, IL 60645
56289	SPRAGUE ELECTRIC CO.	87 MARSHALL ST.	NORTH ADAMS, MA 01247
57668	R-OHM CORP.	16931 MILLIKEN AVE.	IRVINE, CA 92713
58361	GENERAL INSTRUMENT CORP.		
59660	OPTO ELECTRONICS DIV.	3400 HILLVIEW AVE	PALO ALTO, CA 94304
71400	TUSONIX INC.	2155 N FORBES BLVD	TUCSON, AZ 85705
71400	BUSSMAN MFG., DIVISION OF MCGRAW-EDISON CO.	2536 W. UNIVERSITY ST.	ST. LOUIS, MO 63107
72982	ERIE TECHNOLOGICAL PRODUCTS, INC.	644 W. 12TH ST.	ERIE, PA 16512
73138	BECKMAN INSTRUMENTS, INC., HELIPOT DIV.	2500 HARBOR BLVD.	FULLERTON, CA 92634
74970	JOHNSON, E. F., CO.	299 10TH AVE. S. W.	WASECA, MN 56093
75042	TRW ELECTRONIC COMPONENTS, IRC FIXED RESISTORS, PHILADELPHIA DIVISION	401 N. BROAD ST.	PHILADELPHIA, PA 19108
76493	BELL INDUSTRIES, INC., MILLER, J. W., DIV.	19070 REYES AVE., P O BOX 5825	COMPTON, CA 90224
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
91293	JOHANSON MFG. COMPANY	P O BOX 329	BOONTON, NJ 07005
91637	DALE ELECTRONICS, INC.	P. O. BOX 609	COLUMBUS, NE 68601

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A10	670-6993-00		CKT BOARD ASSY:DISPLAY	80009	670-6993-00
A12	670-6994-00		CKT BOARD ASSY:ANALOG	80009	670-6994-00
A14	670-6797-00		CKT BOARD ASSY:GPIB	80009	670-6797-00
A16	670-6998-00		CKT BOARD ASSY:DIGITAL	80009	670-6998-00
A18	670-6996-00		CKT BOARD ASSY:AUXILIARY (STANDARD ONLY)	80009	670-6996-00

A18	670-6997-00		CKT BOARD ASSY:AUXILIARY (OPTION 01 ONLY)	80009	670-6997-00

A10	670-6993-00		CKT BOARD ASSY:DISPLAY	80009	670-6993-00
A10C1321	281-0765-00		CAP.,FXD,CER DI:100PF,5%,100V	51642	G1710-100NP0101J
A10DS1001	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1002	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1003	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1004	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1005	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1101	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1102	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1103	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1104	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1111	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1112	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1113	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1114	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1131	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1132	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1133	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1134	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1201	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1202	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1203	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1211	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1213	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1214	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1221	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1222	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1223	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1224	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1231	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1232	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1233	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1234	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1301	150-1053-00		LAMP,LED RDOUT:ORANGE,7 SEG,0.4 DIGIT	58361	Q3411
A10DS1302	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1303	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1304	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1306	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1311	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1313	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1314	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1321	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1323	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1325	150-1031-00		LT EMITTING DIO:RED,650NM,40MA MAX	53184	XC209R
A10DS1331	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10DS1332	150-1043-00		LT EMITTING DIO:RED,20MA,5V	58361	MV5774C

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A10DS1333	150-1043-00			LT EMITTING DIO:RED,20MA,5V	58361	MV5774C
A10P1001	131-1934-00			TERM. SET,PIN:1 X 36,0.1 CTR,0.9 L	22526	65539-001
A10P1002	131-1934-00			TERM. SET,PIN:1 X 36,0.1 CTR,0.9 L	22526	65539-001
A10P1321	131-1934-00			TERM. SET,PIN:1 X 36,0.1 CTR,0.9 L	22526	65539-001
A10Q1121	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1122	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1123	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1124	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1125	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1126	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1127	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1221	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10Q1222	151-0254-00			TRANSISTOR:SILICON,NPN	03508	X38L3118
A10R1321	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A10S1111	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1111	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1112	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1112	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1113	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1113	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1114	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1114	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1131	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1131	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1132	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1132	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1133	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1133	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1134	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1134	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1211	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1211	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1212	263-0019-03	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1212	263-0019-38	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1213	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1213	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1214	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1214	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1221	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1221	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1222	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1222	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1223	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1223	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1224	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1224	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1231	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1231	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1232	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1232	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1233	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1233	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1234	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1234	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1311	263-0019-01	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1311	263-0019-35	B010240		SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1312	263-0019-30	B010100	B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-30

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A10S1312	263-0019-36	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-36
A10S1313	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1313	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1314	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1314	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1321	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1321	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1322	263-0019-03	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1322	263-0019-38	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1323	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1323	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1324	263-0019-03	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-03
A10S1324	263-0019-38	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-38
A10S1331	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1331	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1332	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1332	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1333	263-0019-01	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-01
A10S1333	263-0019-35	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-35
A10S1334	263-0019-04	B010100 B010239	ACTR ASSY,PB:MOMENTARY	80009	263-0019-04
A10S1334	263-0019-37	B010240	SWITCH,PB ASSY:MOMENTARY	80009	263-0019-37
A10U1121	156-0799-00		MICROCIRCUIT,DI:DECADE CNTR/DTV	80009	156-0799-00

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12	670-6994-00		CKT BOARD ASSY:ANALOG	80009	670-6994-00
A12AT1505	307-1012-00		ATTENUATOR,FXD:5X	80009	307-1012-00
A12AT1533	307-1012-00		ATTENUATOR,FXD:5X	80009	307-1012-00
A12C1003	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1004	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1005	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1010	281-0808-00		CAP.,FXD,CER DI:7PF,20%,100V	72982	8035D9AADC0G709G
A12C1011	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1012	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1013	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1014	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1015	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1020	281-0770-00		CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
A12C1021	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1022	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1023	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1024	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1025	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1030	283-0423-00		CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A12C1031	283-0423-00		CAP.,FXD,CER DI:0.22UF,+80-20%,50V	04222	DG015E224Z
A12C1032	281-0798-00		CAP.,FXD,CER DI:51PF,1%,100V	04222	MC101A510G
A12C1034	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A12C1107	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1108	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1110	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1113	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1114	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1118	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1120	281-0770-00		CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
A12C1121	281-0810-00		CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A12C1122	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1123	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1130	281-0810-00		CAP.,FXD,CER DI:5.6PF,0.5%,100V	04222	GC10-1A5R6D
A12C1131	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A12C1140	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1200	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1201	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1210	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1211	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1212	290-0782-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1213	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1220	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A12C1221	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A12C1230	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1231	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A12C1233	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1234	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A12C1303	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1304	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1312	283-0094-00		CAP.,FXD,CER DI:27PF,10%,200V	59660	835-583-C0G0270K
A12C1313	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A12C1317	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1319	283-0260-00		CAP.,FXD,CER DI:5.6PF,5%,200V	51642	150 200NP0569C
A12C1322	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1323	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1330	283-0094-00		CAP.,FXD,CER DI:27PF,10%,200V	59660	835-583-C0G0270K
A12C1331	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12C1333	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1339	283-0260-00		CAP., FXD, CER DI:5.6PF, 5%, 200V	51642	150 200NP0569C
A12C1401	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1403	283-0107-00		CAP., FXD, CER DI:51PF, 5%, 200V	72982	8121B232C0G0510J
A12C1405	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1412	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	04222	SA205E104MAA
A12C1413	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1414	290-0776-00		CAP., FXD, ELCTLT:22UF, +50-10%, 10V	55680	10ULA22V-T
A12C1415	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	04222	SA205E104MAA
A12C1425	283-0107-00		CAP., FXD, CER DI:51PF, 5%, 200V	72982	8121B232C0G0510J
A12C1432	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	04222	SA205E104MAA
A12C1435	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1500	290-0782-00		CAP., FXD, ELCTLT:4.7UF, +75-10%, 35V	55680	35ULA4R7V-T
A12C1501	281-0770-00		CAP., FXD, CER DI:0.001UF, 20%, 100V	72982	8035D9AADX5R102M
A12C1502	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1503	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1504	283-0185-00		CAP., FXD, CER DI:2.5PF, 5%, 50V	72982	8101B057C0K0295B
A12C1506	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1507	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1509	283-0160-00		CAP., FXD, CER DI:1.5PF, 10%, 50V	72982	8101A058C0K159B
A12C1512	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1513	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1514	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1515	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1516	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1517	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1518	283-0252-00		CAP., FXD, CER DI:1000PF, 10%, 50V	04222	ULA105C102K2T60
A12C1519	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1520	290-0782-00		CAP., FXD, ELCTLT:4.7UF, +75-10%, 35V	55680	35ULA4R7V-T
A12C1521	281-0770-00		CAP., FXD, CER DI:0.001UF, 20%, 100V	72982	8035D9AADX5R102M
A12C1522	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1523	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	04222	SA201C103KAA
A12C1524	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1525	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1527	283-0160-00		CAP., FXD, CER DI:1.5PF, 10%, 50V	72982	8101A058C0K159B
A12C1530	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1531	290-0776-00		CAP., FXD, ELCTLT:22UF, +50-10%, 10V	55680	10ULA22V-T
A12C1532	281-0775-00		CAP., FXD, CER DI:0.1UF, 20%, 50V	04222	SA205E104MAA
A12C1533	283-0185-00		CAP., FXD, CER DI:2.5PF, 5%, 50V	72982	8101B057C0K0295B
A12C1535	283-0252-00		CAP., FXD, CER DI:1000PF, 10%, 50V	04222	ULA105C102K2T60
A12C1536	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1537	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1538	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1539	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1601	281-0773-00		CAP., FXD, CER DI:0.01UF, 10%, 100V	04222	SA201C103KAA
A12C1607	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1610	283-0410-00		CAP., FXD, CER DI:0.022UF, 10%, 500V	91293	501548W223KBS
A12C1611	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1612	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1613	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1614	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1615	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1616	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1617	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1620	283-0410-00		CAP., FXD, CER DI:0.022UF, 10%, 500V	91293	501548W223KBS
A12C1621	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M
A12C1622	283-0220-00		CAP., FXD, CER DI:0.01UF, 20%, 50V	72982	8121N075X7R0103M

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12C1623	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1624	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1625	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1626	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1631	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A12C1632	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1633	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1634	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1635	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1636	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1637	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12C1639	283-0220-00		CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A12CR1111	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1130	152-0269-00		SEMICON D DEVICE:SILICON,VAR VCAP.,4V,33PF	04713	SMV1263
A12CR1200	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1201	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1220	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1300	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1310	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1311	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1320	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1330	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1331	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1332	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1400	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1401	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1410	152-0536-00		SEMICON D DEVICE:SILICON,HOT CARRIER,4V	80009	152-0536-00
A12CR1411	152-0536-00		SEMICON D DEVICE:SILICON,HOT CARRIER,4V	80009	152-0536-00
A12CR1420	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1430	152-0536-00		SEMICON D DEVICE:SILICON,HOT CARRIER,4V	80009	152-0536-00
A12CR1431	152-0536-00		SEMICON D DEVICE:SILICON,HOT CARRIER,4V	80009	152-0536-00
A12CR1510	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1511	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1512	152-0246-00		SEMICON D DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR1513	152-0246-00		SEMICON D DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR1520	152-0141-02		SEMICON D DEVICE:SILICON,30V,150MA	01295	1N4152R
A12CR1530	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1531	152-0322-00		SEMICON D DEVICE:SILICON,15V,HOT CARRIER	50434	5082-2672
A12CR1532	152-0246-00		SEMICON D DEVICE:SW,SI,40V,200MA	03508	DE140
A12CR1533	152-0246-00		SEMICON D DEVICE:SW,SI,40V,200MA	03508	DE140
A12DL500	119-1367-00		DELAY LINE,ELEC:4 NANO SEC,50OHM	80009	119-1367-00
A12J500	131-1097-00		CONNECTOR,RCPT,:BNC,FEMALE,CKT BOARD MT	24931	28JR220-2
A12J510	131-1097-00		CONNECTOR,RCPT,:BNC,FEMALE,CKT BOARD MT	24931	28JR220-2
A12J1010	131-2651-00		CONN,RCPT,ELEC:HEADER,1 X 36,0.1 CTR	22526	65510-436
A12J1102	131-2651-00		CONN,RCPT,ELEC:HEADER,1 X 36,0.1 CTR	22526	65510-436
A12J1130	131-1003-00		CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A12J1201	131-1003-00		CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A12J1230	131-2132-01		CONN,RCPT,ELEC:HEADER,1 X 36,01 CTR	22526	65506-436
A12J1400	131-2132-01		CONN,RCPT,ELEC:HEADER,1 X 36,01 CTR	22526	65506-436
A12J1420	131-2132-01		CONN,RCPT,ELEC:HEADER,1 X 36,01 CTR	22526	65506-436
A12J1510	131-2651-00		CONN,RCPT,ELEC:HEADER,1 X 36,0.1 CTR	22526	65510-436
A12J1520	131-2651-00		CONN,RCPT,ELEC:HEADER,1 X 36,0.1 CTR	22526	65510-436
A12K1500	148-0128-00		RELAY,ARMATURE:1 FORM X & 1 FORM Y,8VDC	80009	148-0128-00
A12K1510	148-0128-00		RELAY,ARMATURE:1 FORM X & 1 FORM Y,8VDC	80009	148-0128-00
A12K1511	148-0128-00		RELAY,ARMATURE:1 FORM X & 1 FORM Y,8VDC	80009	148-0128-00
A12K1520	148-0128-00		RELAY,ARMATURE:1 FORM X & 1 FORM Y,8VDC	80009	148-0128-00
A12K1521	148-0128-00		RELAY,ARMATURE:1 FORM X & 1 FORM Y,8VDC	80009	148-0128-00

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12K1530	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1600	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1610	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1611	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1612	148-0108-00		RELAY, ARMATURE: 2 FORM C, 5VDC COIL, 2A	11532	720-5
A12K1620	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1630	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1631	148-0128-00		RELAY, ARMATURE: 1 FORM X & 1 FORM Y, 8VDC	80009	148-0128-00
A12K1632	148-0108-00		RELAY, ARMATURE: 2 FORM C, 5VDC COIL, 2A	11532	720-5
A12L1009	108-0436-00		COIL, RF: FIXED, 240NH	80009	108-0436-00
A12L1120	120-0382-00		XFMR, TOROID: 14 TURNS, SINGLE	80009	120-0382-00
A12L1220	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1221	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1230	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1231	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1232	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1233	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1302	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1310	108-0262-00		COIL, RF: FIXED, 510NH	80009	108-0262-00
A12L1311	108-0262-00		COIL, RF: FIXED, 510NH	80009	108-0262-00
A12L1312	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1322	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1330	108-0262-00		COIL, RF: FIXED, 510NH	80009	108-0262-00
A12L1331	108-0262-00		COIL, RF: FIXED, 510NH	80009	108-0262-00
A12L1332	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1410	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12L1430	108-0245-00		COIL, RF: 3.9UH	76493	B6310-1
A12Q1000	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A12Q1100	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A12Q1110	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A12Q1111	151-0188-00		TRANSISTOR: SILICON, PNP	04713	SPS6868K
A12Q1112	151-0220-00		TRANSISTOR: SILICON, PNP	07263	S036228
A12Q1114	151-0220-00		TRANSISTOR: SILICON, PNP	07263	S036228
A12Q1122	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1130	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1200	151-0190-00		TRANSISTOR: SILICON, NPN	07263	S032677
A12Q1201	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1202	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1203	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1204	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1210	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1211	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1220	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1221	151-0341-00		TRANSISTOR: SILICON, NPN	07263	S040065
A12Q1222	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1300	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1301	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1302	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1303	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00
A12Q1320	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1321	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1322	151-0369-00		TRANSISTOR: SILICON, PNP	01295	SKA6664
A12Q1323	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00
A12Q1400	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00
A12Q1401	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00
A12Q1402	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00
A12Q1403	151-0427-00		TRANSISTOR: SILICON, NPN	80009	151-0427-00

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12Q1410	151-1117-00		TRANSISTOR:FE DUAL,N-CHANNEL,SI	80009	151-1117-00
A12Q1420	151-0427-00		TRANSISTOR:SILICON,NPN	80009	151-0427-00
A12Q1421	151-0427-00		TRANSISTOR:SILICON,NPN	80009	151-0427-00
A12Q1422	151-0427-00		TRANSISTOR:SILICON,NPN	80009	151-0427-00
A12Q1423	151-0427-00		TRANSISTOR:SILICON,NPN	80009	151-0427-00
A12Q1430	151-1117-00		TRANSISTOR:FE DUAL,N-CHANNEL,SI	80009	151-1117-00
A12R1000	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1001	315-0132-00		RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A12R1002	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1003	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1004	307-0546-00		RES NTWK,FXD FI:5,75 OHM,5%,0.15W	91637	MSP06A01750J
A12R1005	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1006	315-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A12R1007	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1008	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1009	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1010	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1013	315-0132-00		RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A12R1014	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1015	315-0430-00		RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A12R1016	315-0132-00		RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A12R1017	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1018	315-0430-00		RES.,FXD,CMPSN:43 OHM,5%,0.25W	01121	CB4305
A12R1019	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1020	315-0153-00		RES.,FXD,CMPSN:15K OHM,5%,0.25W	01121	CB1535
A12R1021	315-0361-00		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A12R1022	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1023	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1030	315-0393-00		RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A12R1031	315-0912-00		RES.,FXD,CMPSN:9.1K OHM,5%,0.25W	01121	CB9125
A12R1032	315-0113-00		RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
A12R1033	315-0113-00		RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
A12R1034	315-0361-00		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A12R1035	315-0333-00		RES.,FXD,CMPSN:33K OHM,5%,0.25W	01121	CB3335
A12R1036	315-0361-00		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A12R1037	315-0113-00		RES.,FXD,CMPSN:11K OHM,5%,0.25W	01121	CB1135
A12R1101	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A12R1102	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1103	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1104	307-0546-00		RES NTWK,FXD FI:5,75 OHM,5%,0.15W	91637	MSP06A01750J
A12R1105	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1106	315-0472-00		RES.,FXD,CMPSN:4.7K OHM,5%,0.25W	01121	CB4725
A12R1107	321-0085-00		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A12R1108	321-0085-00		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A12R1109	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1110	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A12R1112	321-0085-00		RES.,FXD,FILM:75 OHM,1%,0.125W	91637	MFF1816G75R00F
A12R1113	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1116	315-0391-00		RES.,FXD,CMPSN:390 OHM,5%,0.25W	01121	CB3915
A12R1117	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1118	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A12R1119	315-0750-00		RES.,FXD,CMPSN:75 OHM,5%,0.25W	01121	CB7505
A12R1120	321-0193-00		RES.,FXD,FILM:1K OHM,1%,0.125W	91637	MFF1816G10000F
A12R1121	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A12R1122	307-0489-00		RES,NTWK,FXD,FI:100 OHM,20%,1W	32997	4308R-101-101
A12R1123	315-0510-00		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A12R1124	315-0201-00		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R1125	321-0236-00		RES., FXD, FILM:2.8K OHM, 1%, 0.125W	91637	MFF1816G28000F
A12R1126	321-0251-00		RES., FXD, FILM:4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
A12R1127	315-0751-00		RES., FXD, CMPSN:750 OHM, 5%, 0.25W	01121	CB7515
A12R1128	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1130	315-0431-00		RES., FXD, CMPSN:430 OHM, 5%, 0.25W	01121	CB4315
A12R1131	315-0620-00		RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
A12R1132	315-0620-00		RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
A12R1133	315-0620-00		RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
A12R1140	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A12R1200	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1201	321-0236-00		RES., FXD, FILM:2.8K OHM, 1%, 0.125W	91637	MFF1816G28000F
A12R1202	315-0201-00		RES., FXD, CMPSN:200 OHM, 5%, 0.25W	01121	CB2015
A12R1203	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1204	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1205	321-0251-00		RES., FXD, FILM:4.02K OHM, 1%, 0.125W	91637	MFF1816G40200F
A12R1206	321-0235-00		RES., FXD, FILM:2.74K OHM, 1%, 0.125W	91637	MFF1816G27400F
A12R1207	321-0173-00		RES., FXD, FILM:619 OHM, 1%, 0.125W	91637	MFF1816G619R0F
A12R1208	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1209	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1211	321-0193-00		RES., FXD, FILM:1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A12R1212	315-0271-00		RES., FXD, CMPSN:270 OHM, 5%, 0.25W	01121	CB2715
A12R1213	321-0256-00		RES., FXD, FILM:4.53K OHM, 1%, 0.125W	91637	MFF1816G45300F
A12R1214	321-0203-00		RES., FXD, FILM:1.27K OHM, 1%, 0.125W	91637	MFF1816G12700F
A12R1215	321-0010-00		RES., FXD, FILM:12.4 OHM, 1%, 0.125W	91637	MFF1816G12R40F
A12R1216	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1217	321-0085-00		RES., FXD, FILM:75 OHM, 1%, 0.125W	91637	MFF1816G75R00F
A12R1218	321-0193-00		RES., FXD, FILM:1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A12R1220	321-0193-00		RES., FXD, FILM:1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A12R1221	315-0620-00		RES., FXD, CMPSN:62 OHM, 5%, 0.25W	01121	CB6205
A12R1222	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1223	321-0235-00		RES., FXD, FILM:2.74K OHM, 1%, 0.125W	91637	MFF1816G27400F
A12R1224	321-0173-00		RES., FXD, FILM:619 OHM, 1%, 0.125W	91637	MFF1816G619R0F
A12R1225	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1226	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1230	321-0256-00		RES., FXD, FILM:4.53K OHM, 1%, 0.125W	91637	MFF1816G45300F
A12R1231	321-0203-00		RES., FXD, FILM:1.27K OHM, 1%, 0.125W	91637	MFF1816G12700F
A12R1233	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1234	321-0010-00		RES., FXD, FILM:12.4 OHM, 1%, 0.125W	91637	MFF1816G12R40F
A12R1300	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1301	321-0097-00		RES., FXD, FILM:100 OHM, 1%, 0.125W	91637	MFF1816G100R0F
A12R1302	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1303	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1304	321-0097-00		RES., FXD, FILM:100 OHM, 1%, 0.125W	91637	MFF1816G100R0F
A12R1305	321-0173-00		RES., FXD, FILM:619 OHM, 1%, 0.125W	91637	MFF1816G619R0F
A12R1306	321-0235-00		RES., FXD, FILM:2.74K OHM, 1%, 0.125W	91637	MFF1816G27400F
A12R1307	321-0207-00		RES., FXD, FILM:1.4K OHM, 1%, 0.125W	91637	MFF1816G14000F
A12R1308	321-0193-00		RES., FXD, FILM:1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A12R1309	321-0138-00		RES., FXD, FILM:267 OHM, 1%, 0.125W	91637	MFF1816G267R0F
A12R1313	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1314	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1315	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1316	321-0239-00		RES., FXD, FILM:3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A12R1317	321-0239-00		RES., FXD, FILM:3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A12R1318	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A12R1319	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1320	321-0097-00		RES., FXD, FILM:100 OHM, 1%, 0.125W	91637	MFF1816G100R0F
A12R1321	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R1322	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1323	321-0097-00		RES., FXD, FILM:100 OHM, 1%, 0.125W	91637	MFF1816G100R0F
A12R1324	321-0173-00		RES., FXD, FILM:619 OHM, 1%, 0.125W	91637	MFF1816G619R0F
A12R1325	321-0235-00		RES., FXD, FILM:2.74K OHM, 1%, 0.125W	91637	MFF1816G27400F
A12R1326	321-0207-00		RES., FXD, FILM:1.4K OHM, 1%, 0.125W	91637	MFF1816G14000F
A12R1327	321-0193-00		RES., FXD, FILM:1K OHM, 1%, 0.125W	91637	MFF1816G10000F
A12R1328	321-0138-00		RES., FXD, FILM:267 OHM, 1%, 0.125W	91637	MFF1816G267R0F
A12R1329	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1331	315-0271-00		RES., FXD, CMPSN:270 OHM, 5%, 0.25W	01121	CB2715
A12R1332	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1333	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1334	315-0302-00		RES., FXD, CMPSN:3K OHM, 5%, 0.25W	01121	CB3025
A12R1335	321-0239-00		RES., FXD, FILM:3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A12R1336	321-0239-00		RES., FXD, FILM:3.01K OHM, 1%, 0.125W	91637	MFF1816G30100F
A12R1337	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A12R1339	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1400	321-0259-00		RES., FXD, FILM:4.87K OHM, 1%, 0.125W	91637	MFF1816G48700F
A12R1401	321-0186-00		RES., FXD, FILM:845 OHM, 1%, 0.125W	91637	MFF1816G845R0F
A12R1402	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1403	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1404	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
A12R1405	317-0150-00		RES., FXD, CMPSN:15 OHM, 5%, 0.125W	01121	BB1505
A12R1406	317-0150-00		RES., FXD, CMPSN:15 OHM, 5%, 0.125W	01121	BB1505
A12R1407	307-0488-00		RES, NTWK, FXD, FI:100 OHM, 20%, 0.75W	01121	206A101
A12R1408	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1409	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1411	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1412	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1413	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A12R1417	307-0514-00		RES., FXD, FILM:27 OHM, 1%, 0.075W	52262	MCRA270FYZ
A12R1420	321-0186-00		RES., FXD, FILM:845 OHM, 1%, 0.125W	91637	MFF1816G845R0F
A12R1421	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1422	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1423	321-0259-00		RES., FXD, FILM:4.87K OHM, 1%, 0.125W	91637	MFF1816G48700F
A12R1424	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
A12R1425	317-0150-00		RES., FXD, CMPSN:15 OHM, 5%, 0.125W	01121	BB1505
A12R1426	317-0150-00		RES., FXD, CMPSN:15 OHM, 5%, 0.125W	01121	BB1505
A12R1427	307-0488-00		RES, NTWK, FXD, FI:100 OHM, 20%, 0.75W	01121	206A101
A12R1428	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1429	315-0470-00		RES., FXD, CMPSN:47 OHM, 5%, 0.25W	01121	CB4705
A12R1432	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1433	315-0101-00		RES., FXD, CMPSN:100 OHM, 5%, 0.25W	01121	CB1015
A12R1434	315-0102-00		RES., FXD, CMPSN:1K OHM, 5%, 0.25W	01121	CB1025
A12R1438	307-0514-00		RES., FXD, FILM:27 OHM, 1%, 0.075W	52262	MCRA270FYZ
A12R1500	321-0199-00		RES., FXD, FILM:1.15K OHM, 1%, 0.125W	91637	MFF1816G11500F
A12R1501	321-0256-00		RES., FXD, FILM:4.53K OHM, 1%, 0.125W	91637	MFF1816G45300F
A12R1502	315-0203-00		RES., FXD, CMPSN:20K OHM, 5%, 0.25W	01121	CB2035
A12R1503	315-0510-00		RES., FXD, CMPSN:51 OHM, 5%, 0.25W	01121	CB5105
A12R1504	321-0481-00		RES., FXD, FILM:1M OHM, 1%, 0.125W	24546	NA4D1004F
A12R1506	317-0361-00		RES., FXD, CMPSN:360 OHM, 5%, 0.125W	01121	BB3615
A12R1507	317-0111-00		RES., FXD, CMPSN:110 OHM, 5%, 0.125W	01121	BB1115
A12R1510	317-0564-00		RES., FXD, CMPSN:560K OHM, 5%, 0.125W	01121	BB5645
A12R1511	321-0068-00		RES., FXD, FILM:49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1512	315-0103-00		RES., FXD, CMPSN:10K OHM, 5%, 0.25W	01121	CB1035
A12R1514	323-0107-00		RES., FXD, FILM:127 OHM, 1%, 0.50W	75042	CECT0-1270F
A12R1515	323-0107-00		RES., FXD, FILM:127 OHM, 1%, 0.50W	75042	CECT0-1270F
A12R1516	307-0734-00		RES., FXD, FILM:200 OHM, 1%, 0.5W	03888	PCWT200X235

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A12R1520	321-0199-00		RES., FXD, FILM: 1.15K OHM, 1%, 0.125W	91637	MFF1816G11500F
A12R1521	321-0256-00		RES., FXD, FILM: 4.53K OHM, 1%, 0.125W	91637	MFF1816G45300F
A12R1522	315-0203-00		RES., FXD, CMPSN: 20K OHM, 5%, 0.25W	01121	CB2035
A12R1523	315-0510-00		RES., FXD, CMPSN: 51 OHM, 5%, 0.25W	01121	CB5105
A12R1524	321-0068-00		RES., FXD, FILM: 49.9 OHM, 1%, 0.125W	91637	MFF1816G49R90F
A12R1525	315-0103-00		RES., FXD, CMPSN: 10K OHM, 5%, 0.25W	01121	CB1035
A12R1526	323-0107-00		RES., FXD, FILM: 127 OHM, 1%, 0.50W	75042	CECT0-1270F
A12R1527	323-0107-00		RES., FXD, FILM: 127 OHM, 1%, 0.50W	75042	CECT0-1270F
A12R1528	307-0734-00		RES., FXD, FILM: 200 OHM, 1%, 0.5W	03888	PCWT200X235
A12R1530	317-0564-00		RES., FXD, CMPSN: 560K OHM, 5%, 0.125W	01121	BB5645
A12R1531	321-0481-00		RES., FXD, FILM: 1M OHM, 1%, 0.125W	24546	NA4D1004F
A12R1535	317-0111-00		RES., FXD, CMPSN: 110 OHM, 5%, 0.125W	01121	BB1115
A12R1536	317-0361-00		RES., FXD, CMPSN: 360 OHM, 5%, 0.125W	01121	BB3615
A12R1601	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
A12R1610	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	CB3905
A12R1611	307-0733-00		RES., FXD, FILM: 25 OHM, 1%, 0.5W	03888	PCWT200X235
A12R1612	315-0394-00		RES., FXD, CMPSN: 390K OHM, 5%, 0.25W	01121	CB3945
A12R1620	315-0394-00		RES., FXD, CMPSN: 390K OHM, 5%, 0.25W	01121	CB3945
A12R1631	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
A12R1632	315-0390-00		RES., FXD, CMPSN: 39 OHM, 5%, 0.25W	01121	CB3905
A12T1410	120-0286-00		XFMR, TOROID: 2 TURNS, BIFILAR	80009	120-0286-00
A12T1430	120-0286-00		XFMR, TOROID: 2 TURNS, BIFILAR	80009	120-0286-00
A12TP1020	214-0579-00		TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12TP1310	214-0579-00		TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12TP1330	214-0579-00		TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A12U1000	156-1031-00		MICROCIRCUIT, DI: TRIPLE D FLIPFLOP	07263	F100131FC
A12U1001	156-1032-00		MICROCIRCUIT, DI: QUINT 2 OR/NOR	07263	F100102FC
A12U1011	156-1031-00		MICROCIRCUIT, DI: TRIPLE D FLIPFLOP	07263	F100131FC
A12U1020	156-1449-00		MICROCIRCUIT, DI: DIVIDE BY 80 150MHZ	52648	SP8627DG
A12U1021	156-0124-00		MICROCIRCUIT, DI: SGL FREQ/PHASE DETECTOR	80009	156-0124-00
A12U1022	156-1031-00		MICROCIRCUIT, DI: TRIPLE D FLIPFLOP	07263	F100131FC
A12U1030	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
A12U1110	156-1032-00		MICROCIRCUIT, DI: QUINT 2 OR/NOR	07263	F100102FC
A12U1200	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RCTR	80009	156-0796-00
A12U1202	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
A12U1210	156-0494-00		MICROCIRCUIT, DI: HEX INVERTER/BUFFER	80009	156-0494-00
A12U1310	155-0253-00		MICROCIRCUIT, LI: HIGH SPEED SCHMITT TRIGGER	80009	155-0253-00
A12U1311	155-0078-10		MICROCIRCUIT, LI: ML, VERTICAL AMPLIFIER	80009	155-0078-10
A12U1330	155-0253-00		MICROCIRCUIT, LI: HIGH SPEED SCHMITT TRIGGER	80009	155-0253-00
A12U1331	155-0078-10		MICROCIRCUIT, LI: ML, VERTICAL AMPLIFIER	80009	155-0078-10
A12VR1412	152-0693-00		SEMICONDC DEVICE: ZENER, 0.4W, 4V, 5%	80009	152-0693-00
A12VR1413	152-0693-00		SEMICONDC DEVICE: ZENER, 0.4W, 4V, 5%	80009	152-0693-00
A12VR1432	152-0693-00		SEMICONDC DEVICE: ZENER, 0.4W, 4V, 5%	80009	152-0693-00
A12VR1433	152-0693-00		SEMICONDC DEVICE: ZENER, 0.4W, 4V, 5%	80009	152-0693-00

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A14	670-6797-00		CKT BOARD ASSY:GPIB	80009	670-6797-00
A14C1001	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1002	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1110	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1201	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1202	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1210	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1301	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1302	281-0811-00		CAP.,FXD,CER DI:10PF,10%,100V	72982	8035D2AADC1G100K
A14C1310	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14C1311	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A14Q1101	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A14R1101	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A14R1210	307-0597-00		RES NTWK,FXD,FI:7,6.8K OHM,2%,1.0W	01121	208A682
A14R1301	315-0303-00		RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
A14S1210	260-1589-00		SWITCH,PUSH:(6)SPST,0.1A,5V	00779	435166-4
A14U1001	156-1414-00		MICROCIRCUIT,DI:OCTAL GPIB XCVR DATA BUS	01295	SN75160
A14U1002	156-1415-00		MICROCIRCUIT,DI:OCTAL GPIB XCVR MTG BUS	01295	SN75161
A14U1101	156-1444-01		MICROCIRCUIT,DI:NMOS GPIB ADAPTER	01295	9914A-N
A14U1102	160-1091-00		MICROCIRCUIT,DI:4096 X 8 MROM,,PRGM	55576	SYP2333
A14U1201	160-1092-00		MICROCIRCUIT,DI:4096 X 8 MROM,PRGM	55576	SYP2333
A14U1210	156-1484-00		MICROCIRCUIT,DI:256 X 8 SCRUM	0001D	35392C
A14U1301	156-1425-00		MICROCIRCUIT,DI:MICROPROCESSOR8 BIT	55576	SYP6502
A14U1310	156-0649-00		MICROCIRCUIT,DI:3 STATE HEX. NON INVT BFR	80009	156-0649-00
A14U1311	156-0469-00		MICROCIRCUIT,DI:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A14U1312	156-0382-00		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
A14U1313	156-0382-00		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A16	670-6998-00		CKT BOARD ASSY:DIGITAL	80009	670-6998-00
A16C1020	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A16C1021	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1022	290-0746-00		CAP.,FXD,ELCTLT:47UF,+50-10%,16V	55680	16U-47V-T
A16C1023	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1101	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1121	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1201	290-0755-00		CAP.,FXD,ELCTLT:100UF,+50-10%,10V	56289	502D223
A16C1211	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1401	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1501	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1520	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A16C1601	281-0811-00		CAP.,FXD,CER DI:10PF,10%,100V	72982	8035D2AADC1G100K
A16C1610	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1621	281-0812-00		CAP.,FXD,CER DI:1000PF,10%,100V	72982	8035D9AADX7R102K
A16C1721	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A16C1722	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A16C1723	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1801	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A16C1810	290-0745-00		CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A16CR1001	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A16CR1010	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A16CR1020	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A16CR1620	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A16CR1720	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A16CR1721	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A16F1820	159-0042-00		FUSE,CARTRIDGE:3AG,0.75A,250V,FAST-BLOW	71400	AGC 3/4
A16F1821	159-0015-00		FUSE,CARTRIDGE:3AG,3A,250V,0.65 SEC	71400	AGC 3
A16J1001	131-1632-00		CONNECTOR,RCPT,:CKT CD MTG,20CONTACT,FEM	22526	65001-025
A16J1210	131-2132-01		CONN,RCPT,ELEC:HEADER,1 X 36,01 CTR	22526	65506-436
A16J1211	131-2132-01		CONN,RCPT,ELEC:HEADER,1 X 36,01 CTR	22526	65506-436
A16L1020	108-0473-00		COIL,RF:150UH	80009	108-0473-00
A16Q1701	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A16Q1702	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A16Q1703	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A16Q1704	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A16Q1720	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A16Q1721	151-0432-00		TRANSISTOR:SILICON,NPN	27014	T07391E2
A16Q1722	151-0453-00		TRANSISTOR:SILICON,PNP	80009	151-0453-00
A16Q1723	151-0453-00		TRANSISTOR:SILICON,PNP	80009	151-0453-00
A16R1001	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1002	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1003	307-0106-00		RES.,FXD,CMPSN:4.7 OHM,5%,0.25W	01121	CB47G5
A16R1004	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1005	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1006	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1007	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1008	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1009	315-0200-00		RES.,FXD,CMPSN:20 OHM,5%,0.25W	01121	CB2005
A16R1010	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A16R1011	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A16R1012	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A16R1013	315-0100-00		RES.,FXD,CMPSN:10 OHM,5%,0.25W	01121	CB1005
A16R1014	307-0675-00		RES NTWK,FXD F1:9,1K OHM,2%,1.25W	01121	210A102
A16R1021	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1022	315-0222-00		RES.,FXD,CMPSN:2.2K OHM,5%,0.25W	01121	CB2225
A16R1103	315-0105-00		RES.,FXD,CMPSN:1M OHM,5%,0.25W	01121	CB1055

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Name & Description	Mfr Code	Mfr Part Number
A16R1201	321-0311-00			RES.,FXD,FILM:16.9K OHM,1%,0.125W	91637	MFF1816G16901F
A16R1202	321-0318-00			RES.,FXD,FILM:20K OHM,1%,0.125W	91637	MFF1816G20001F
A16R1203	321-0275-00			RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
A16R1204	321-0275-00			RES.,FXD,FILM:7.15K OHM,1%,0.125W	91637	MFF1816G71500F
A16R1205	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1206	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R1207	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R1208	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R1209	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R1210	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A16R1220	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1301	315-0103-00			RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A16R1420	307-0446-00			RES,NTWK,FXD FI:10K OHM,20%,(9) RES	91637	MSP10A01-103M
A16R1520	315-0393-00			RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A16R1521	315-0104-00			RES.,FXD,CMPSN:100K OHM,5%,0.25W	01121	CB1045
A16R1601	315-0303-00			RES.,FXD,CMPSN:30K OHM,5%,0.25W	01121	CB3035
A16R1620	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
A16R1621	315-0272-00			RES.,FXD,CMPSN:2.7K OHM,5%,0.25W	01121	CB2725
A16R1622	315-0202-00			RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A16R1701	315-0560-00	B010100	B019999	RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
A16R1701	315-0510-00	B020000		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A16R1702	315-0560-00	B010100	B019999	RES.,FXD,CMPSN:56 OHM,5%,0.25W	01121	CB5605
A16R1702	315-0510-00	B020000		RES.,FXD,CMPSN:51 OHM,5%,0.25W	01121	CB5105
A16R1703	307-0541-00			RES,NTWK,THK FI:(7)1K OHM,10%,1W	91637	MSP08A01-102G
A16R1710	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1711	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1712	315-0362-00			RES.,FXD,CMPSN:3.6K OHM,5%,0.25W	01121	CB3625
A16R1713	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1714	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1715	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1716	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A16R1717	315-0201-00			RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A16R1718	308-0677-00			RES.,FXD,WW:1 OHM,5%,2W	75042	BWH-1R000J
A16R1719	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1720	315-0101-00			RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A16R1721	315-0152-00			RES.,FXD,CMPSN:1.5K OHM,5%,0.25W	01121	CB1525
A16R1722	315-0132-00			RES.,FXD,CMPSN:1.3K OHM,5%,0.25W	01121	CB1325
A16R1724	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A16R1725	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A16R1726	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1727	321-0231-00			RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A16R1728	308-0244-00			RES.,FXD,WW:0.3 OHM,10%,2W	91637	RS2B162ER3000K
A16R1820	315-0102-00			RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A16R1821	321-0297-00			RES.,FXD,FILM:12.1K OHM,1%,0.125W	91637	MFF1816G12101F
A16S1210	260-1589-00			SWITCH,PUSH:(6)SPST,0.1A,5V	00779	435166-4
A16TP1410	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A16TP1411	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A16TP1420	214-0579-00			TERM,TEST POINT:BRS CD PL	80009	214-0579-00
A16U1101	156-1243-00			MICROCIRCUIT,DI:BCD-TO-7 SEGMENT DECODER	80009	156-1243-00
A16U1102	156-0411-00			MICROCIRCUIT,LI:QUAD-COMP,SGI SUPPLY	27014	LM339N
A16U1110	156-1245-00			MICROCIRCUIT,LI:7 XSTR,HV/HIGH CUR	04713	MC1413PDS
A16U1111	156-0391-00			MICROCIRCUIT,DI:HEX LATCH WITH CLEAR	04713	74LS174(N OR J)
A16U1112	156-0391-00			MICROCIRCUIT,DI:HEX LATCH WITH CLEAR	04713	74LS174(N OR J)
A16U1113	156-1172-00			MICROCIRCUIT,DI:DUAL 4 BIT BIN CNTR	80009	156-1172-00
A16U1114	156-0576-00			MICROCIRCUIT,DI:8 BIT PRL INP-SERIAL OUTPT	04713	MC14021BCL
A16U1115	156-0579-00			MICROCIRCUIT,DI:DUAL 4-BIT BIN COUNTER	04713	MC14520BCL

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A16U1120	156-0388-00		MICROCIRCUIT,DI:DUAL D-TYPE FLIP-FLOP	80009	156-0388-00
A16U1121	156-0576-00		MICROCIRCUIT,DI:8 BIT PRL INP-SERIAL OUTPT	04713	MC14021BCL
A16U1122	156-0576-00		MICROCIRCUIT,DI:8 BIT PRL INP-SERIAL OUTPT	04713	MC14021BCL
A16U1210	156-0649-00		MICROCIRCUIT,DI:3 STATE HEX. NON INVT BFR	80009	156-0649-00
A16U1211	156-0576-00		MICROCIRCUIT,DI:8 BIT PRL INP-SERIAL OUTPT	04713	MC14021BCL
A16U1212	156-0545-00		MICROCIRCUIT,DI:12-BIT BINARY COUNTER	80009	156-0545-00
A16U1310	156-0649-00		MICROCIRCUIT,DI:3 STATE HEX. NON INVT BFR	80009	156-0649-00
A16U1311	156-1484-00		MICROCIRCUIT,DI:256 X 8 SCRM	000ID	35392C
A16U1312	156-0576-00		MICROCIRCUIT,DI:8 BIT PRL INP-SERIAL OUTPT	04713	MC14021BCL
A16U1313	156-0469-00		MICROCIRCUIT,DI:3-LINE TO 8-LINE DECODER	01295	SN74LS138N
A16U1314	156-0494-00		MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
A16U1410	160-1183-00		MICROCIRCUIT,DI:I/O TIMER,ROM, RAM, PRGM	34576	R6531P
A16U1420	156-0541-00		MICROCIRCUIT,DI:DECODER/DEMULTIPLEXER	27014	DM74LS139N
A16U1421	156-0382-00		MICROCIRCUIT,DI:QUAD 2-INPUT NAND GATE	01295	SN74LS00(N OR J)
A16U1520	156-0494-00		MICROCIRCUIT,DI:HEX INVERTER/BUFFER	80009	156-0494-00
A16U1610	160-1111-00		MICROCIRCUIT,DI:4096 X 8 MROM, PRGM	80009	160-1111-00
A16U1710	156-0411-00		MICROCIRCUIT,LI:QUAD-COMP, SGL SUPPLY	27014	LM339N
A16U1720	156-0071-00		MICROCIRCUIT,LI:VOLTAGE REGULATOR	04713	MC1723CL
A16U1801	156-0230-00		MICROCIRCUIT,DI:DUAL D MA-SLAVE FLIP-FLOP	04713	MC10131 (L OR P)
A16U1810	156-0880-00		MICROCIRCUIT,DI:DUAL D MASTER SLAVE FF	80009	156-0880-00
A16W1303	131-0566-00	B010100 B019999X	BUS CONDUCTOR:DUMMY RES,2.375,22 AWG	57668	JWW-0200E0

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A18	670-6996-00		CKT BOARD ASSY:AUXILIARY (STANDARD ONLY)	80009	670-6996-00
A18	670-6997-00		CKT BOARD ASSY:AUXILIARY (OPTION 01 ONLY)	80009	670-6997-00
A18C1030	290-0745-00		CAP.,FXD,ELCTLT:22UF,+50-10%,25V	56289	502D225
A18C1031	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A18C1230	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A18C1231	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1232	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1300	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1301	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A18C1310	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1320	281-0770-00		CAP.,FXD,CER DI:0.001UF,20%,100V	72982	8035D9AADX5R102M
A18C1321	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A18C1322	290-0776-00		CAP.,FXD,ELCTLT:22UF,+50-10%,10V	55680	10ULA22V-T
A18C1324	290-0782-00		CAP.,FXD,ELCTLT:4.7UF,+75-10%,35V	55680	35ULA4R7V-T
A18C1330	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1331	283-0220-00	B010100 B010469	CAP.,FXD,CER DI:0.01UF,20%,50V	72982	8121N075X7R0103M
A18C1331	281-0773-00	B010470	CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A18C1332	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1410	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1411	281-0773-00		CAP.,FXD,CER DI:0.01UF,10%,100V	04222	SA201C103KAA
A18C1413	281-0814-00		CAP.,FXD,CER DI:100PF,10%,100V	04222	GC70-1-A101K
A18C1420	281-0630-00		CAP.,FXD,CER DI:390PF,5%,500V (STANDARD ONLY)	72982	630000Y5D391J
A18C1421	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V (STANDARD ONLY)	04222	SA205E104MAA
A18C1430	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V (OPTION 01 ONLY)	04222	SA205E104MAA
A18C1431	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V (OPTION 01 ONLY)	04222	SA205E104MAA
A18C1510	281-0775-00		CAP.,FXD,CER DI:0.1UF,20%,50V	04222	SA205E104MAA
A18C1521	281-0198-00		CAP.,VAR,AIR DI:1.7-11PF,250V (STANDARD ONLY)	74970	187-0306-105
A18C1522	281-0564-00		CAP.,FXD,CER DI:24PF,5%,500V (STANDARD ONLY)	59660	301-000C0G0240J
A18C1523	281-0630-00		CAP.,FXD,CER DI:390PF,5%,500V (STANDARD ONLY)	72982	630000Y5D391J
A18CR1120	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1121	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1122	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1123	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1124	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1232	152-0066-00		SEMICONV DEVICE:SILICON,400V,750MA	14433	LG4016
A18CR1500	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A18CR1510	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A18CR1511	152-0141-02		SEMICONV DEVICE:SILICON,30V,150MA	01295	1N4152R
A18F1510	159-0042-00		FUSE,CARTRIDGE:3AG,0.75A,250V,FAST-BLOW	71400	AGC 3/4
A18F1511	159-0015-00		FUSE,CARTRIDGE:3AG,3A,250V,0.65 SEC	71400	AGC 3
A18J1500	131-1003-00		CONN,RCPT,ELEC:CKT BD MT,3 PRONG	80009	131-1003-00
A18J1510	131-1857-00		TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A18J1511	131-1857-00		TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A18J1611	131-1857-00		TERM. SET,PIN:36/0.025 SQ PIN,ON 0.1 CTRS	22526	65500136
A18L1420	108-0245-00		COIL,RF:3.9UH	76493	B6310-1
A18L1421	108-0245-00		COIL,RF:3.9UH	76493	B6310-1
A18Q1030	151-0342-00		TRANSISTOR:SILICON,PNP	07263	S035928
A18Q1031	151-0341-00		TRANSISTOR:SILICON,PNP	07263	S040065
A18Q1032	151-0335-00		TRANSISTOR:SILICON,PNP	04713	SJE917
A18Q1120	151-0254-00		TRANSISTOR:SILICON,PNP	03508	X38L3118
A18Q1121	151-0254-00		TRANSISTOR:SILICON,PNP	03508	X38L3118

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A18Q1300	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A18Q1330	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A18Q1331	151-0342-00		TRANSISTOR:SILICON,PNP	07263	S035928
A18Q1332	151-0462-00		TRANSISTOR:SILICON,PNP	04713	SJE491
A18Q1333	151-0341-00		TRANSISTOR:SILICON,NPN	07263	S040065
A18Q1401	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A18Q1420	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
	-----		(STANDARD ONLY)		
A18Q1500	151-0188-00		TRANSISTOR:SILICON,PNP	04713	SPS6868K
A18Q1510	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A18Q1511	151-0190-00		TRANSISTOR:SILICON,NPN	07263	S032677
A18R1000	315-0101-00		RES.,FXD,CMPSN:100 OHM,5%,0.25W	01121	CB1015
A18R1030	315-0301-00		RES.,FXD,CMPSN:300 OHM,5%,0.25W	01121	CB3015
A18R1031	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A18R1032	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215
A18R1033	315-0431-00		RES.,FXD,CMPSN:430 OHM,5%,0.25W	01121	CB4315
A18R1100	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A18R1101	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A18R1110	321-0229-00		RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
A18R1111	321-0239-00		RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A18R1112	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A18R1113	315-0103-00		RES.,FXD,CMPSN:10K OHM,5%,0.25W	01121	CB1035
A18R1114	321-0229-00		RES.,FXD,FILM:2.37K OHM,1%,0.125W	91637	MFF1816G23700F
A18R1115	321-0239-00		RES.,FXD,FILM:3.01K OHM,1%,0.125W	91637	MFF1816G30100F
A18R1120	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A18R1121	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A18R1200	321-0197-00		RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
A18R1201	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
A18R1202	321-0197-00		RES.,FXD,FILM:1.1K OHM,1%,0.125W	91637	MFF1816G11000F
A18R1203	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
A18R1204	311-1236-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A18R1205	311-1236-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A18R1206	311-1236-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A18R1207	311-1236-00		RES.,VAR,NONWIR:250 OHM,10%,0.50W	73138	72-22-0
A18R1210	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
A18R1211	321-0189-00		RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G9090F
A18R1212	321-0173-00		RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G6190F
A18R1213	321-0173-00		RES.,FXD,FILM:619 OHM,1%,0.125W	91637	MFF1816G6190F
A18R1214	321-0189-00		RES.,FXD,FILM:909 OHM,1%,0.125W	91637	MFF1816G9090F
A18R1215	321-0202-00		RES.,FXD,FILM:1.24K OHM,1%,0.125W	91637	MFF1816G12400F
A18R1310	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A18R1311	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A18R1312	315-0393-00		RES.,FXD,CMPSN:39K OHM,5%,0.25W	01121	CB3935
A18R1313	321-0287-00		RES.,FXD,FILM:9.53K OHM,1%,0.125W	91637	MFF1816G95300F
A18R1314	321-0231-00		RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A18R1315	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A18R1321	321-0231-00		RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A18R1322	321-0231-00		RES.,FXD,FILM:2.49K OHM,1%,0.125W	91637	MFF1816G24900F
A18R1323	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A18R1324	315-0202-00		RES.,FXD,CMPSN:2K OHM,5%,0.25W	01121	CB2025
A18R1331	315-0511-00		RES.,FXD,CMPSN:510 OHM,5%,0.25W	01121	CB5115
A18R1332	315-0361-00		RES.,FXD,CMPSN:360 OHM,5%,0.25W	01121	CB3615
A18R1333	315-0751-00		RES.,FXD,CMPSN:750 OHM,5%,0.25W	01121	CB7515
A18R1334	315-0201-00		RES.,FXD,CMPSN:200 OHM,5%,0.25W	01121	CB2015
A18R1335	315-0681-00		RES.,FXD,CMPSN:680 OHM,5%,0.25W	01121	CB6815
A18R1400	315-0512-00		RES.,FXD,CMPSN:5.1K OHM,5%,0.25W	01121	CB5125
A18R1401	315-0102-00		RES.,FXD,CMPSN:1K OHM,5%,0.25W	01121	CB1025
A18R1402	315-0121-00		RES.,FXD,CMPSN:120 OHM,5%,0.25W	01121	CB1215

Replaceable Electrical Parts—DC 5010

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A18R1403	315-0104-00		RES., FXD, CMPSN: 100K OHM, 5%, 0.25W	01121	CB1045
A18R1410	315-0105-00		RES., FXD, CMPSN: 1M OHM, 5%, 0.25W	01121	CB1055
A18R1411	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A18R1412	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
A18R1413	315-0101-00		RES., FXD, CMPSN: 100 OHM, 5%, 0.25W	01121	CB1015
A18R1414	315-0302-00		RES., FXD, CMPSN: 3K OHM, 5%, 0.25W	01121	CB3025
A18R1420	315-0152-00		RES., FXD, CMPSN: 1.5K OHM, 5%, 0.25W	01121	CB1525
	-----		(STANDARD ONLY)		
A18R1421	315-0102-00		RES., FXD, CMPSN: 1K OHM, 5%, 0.25W	01121	CB1025
	-----		(STANDARD ONLY)		
A18R1424	315-0562-00		RES., FXD, CMPSN: 5.6K OHM, 5%, 0.25W	01121	CB5625
	-----		(STANDARD ONLY)		
A18R1425	308-0058-00		RES., FXD, WW: 1.5 OHM, 10%, 1W	75042	BW20-1R500K
A18R1426	308-0742-00		RES., FXD, WW: 0.24 OHM, 5%, 2W	75042	BWH-R2400J
A18R1430	321-0213-00		RES., FXD, FILM: 1.62K OHM, 1%, 0.125W	91637	MFF1816G16200F
	-----		(OPTION 01 ONLY)		
A18R1431	321-0105-00		RES., FXD, FILM: 121 OHM, 1%, 0.125W	91637	MFF1816G121R0F
	-----		(OPTION 01 ONLY)		
A18R1500	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A18R1501	315-0181-00		RES., FXD, CMPSN: 180 OHM, 5%, 0.25W	01121	CB1815
A18R1502	315-0112-00		RES., FXD, CMPSN: 1.1K OHM, 5%, 0.25W	01121	CB1125
A18R1503	315-0242-00		RES., FXD, CMPSN: 2.4K OHM, 5%, 0.25W	01121	CB2425
A18R1504	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A18R1510	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A18R1511	315-0122-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
A18R1512	315-0472-00		RES., FXD, CMPSN: 4.7K OHM, 5%, 0.25W	01121	CB4725
A18R1513	315-0122-00		RES., FXD, CMPSN: 1.2K OHM, 5%, 0.25W	01121	CB1225
A18R1514	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A18R1515	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A18R1516	315-0511-00		RES., FXD, CMPSN: 510 OHM, 5%, 0.25W	01121	CB5115
A18R1520	315-0183-00		RES., FXD, CMPSN: 18K OHM, 5%, 0.25W	01121	CB1835
	-----		(STANDARD ONLY)		
A18TP1400	214-0579-00		TERM, TEST POINT: BRS CD PL	80009	214-0579-00
A18U1010	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RGTR	80009	156-0796-00
A18U1020	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RGTR	80009	156-0796-00
A18U1021	156-1245-00		MICROCIRCUIT, LI: 7 XSTR, HV/HIGH CUR	04713	MC1413PDS
A18U1110	156-1245-00		MICROCIRCUIT, LI: 7 XSTR, HV/HIGH CUR	04713	MC1413PDS
A18U1111	156-0411-00		MICROCIRCUIT, LI: QUAD-COMP, SGL SUPPLY	27014	LM339N
A18U1200	156-0158-00		MICROCIRCUIT, LI: DUAL OPERATIONAL AMPLIFIER	18324	MC1458N
A18U1210	156-0927-00		MICROCIRCUIT, LI: DIGITAL TO ANALOG CONVERTER	80009	156-0927-00
A18U1220	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RGTR	80009	156-0796-00
A18U1221	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RGTR	80009	156-0796-00
A18U1222	156-0796-00		MICROCIRCUIT, DI: 8 STG SHF & STORE BUS RGTR	80009	156-0796-00
A18U1223	156-1173-00		MICROCIRCUIT, LI: VOLTAGE REFERENCE	04713	MC1403UDS
A18U1310	156-0927-00		MICROCIRCUIT, LI: DIGITAL TO ANALOG CONVERTER	80009	156-0927-00
A18U1320	156-0071-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	04713	MC1723CL
A18U1330	156-1150-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR, NEGATIVE	04713	MC79L05ACP
A18U1400	156-1126-00		MICROCIRCUIT, LI: VOLTAGE COMPARATOR	51984	UPC311C
A18U1410	156-1433-00		MICROCIRCUIT, DI: NOISE SOURCE	27014	MM5837N
A18U1411	156-0656-00		MICROCIRCUIT, DI: DECADE COUNTER	01295	SN74LS90N OR J
A18U1420	156-0071-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	04713	MC1723CL
A18U1430	156-1161-00		MICROCIRCUIT, LI: VOLTAGE REGULATOR	27014	LM317T
	-----		(OPTION 01 ONLY)		
A18U1500	156-0385-00		MICROCIRCUIT, DI: HEX. INVERTER	80009	156-0385-00
A18VR1001	152-0195-00		SEMICONV DEVICE: ZENER, 0.4W, 5.1V, 5%	04713	SZ11755
A18VR1410	152-0166-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	SZ11738
A18VR1411	152-0166-00		SEMICONV DEVICE: ZENER, 0.4W, 6.2V, 5%	04713	SZ11738

Component No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Name & Description	Mfr Code	Mfr Part Number
A18Y1520	158-0129-00 -----		XTAL UNIT,QTZ:10MHZ,0.001%,PARALLEL (STANDARD ONLY)	33096	PB1109
A18Y1530	119-0894-01 -----		OSCILLATOR,RF:10MHZ,18V (OPTION 01 ONLY)	80009	119-0894-01

DIAGRAMS AND CIRCUIT BOARD ILLUSTRATIONS

Symbols

Graphic symbols and class designation letters are based on ANSI Standard Y32.2-1975.

Logic symbology is based on ANSI Y32.14-1973 in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The overline on a signal name indicates that the signal performs its intended function when it is in the low state.

Abbreviations are based on ANSI Y1.1-1972.

Other ANSI standards that are used in the preparation of diagrams by Tektronix, Inc. are:

Y14.15, 1966 Drafting Practices.
Y14.2, 1973 Line Conventions and Lettering.
Y10.5, 1968 Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering.

American National Standard Institute
1430 Broadway
New York, New York 10018

Component Values

Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μ F).

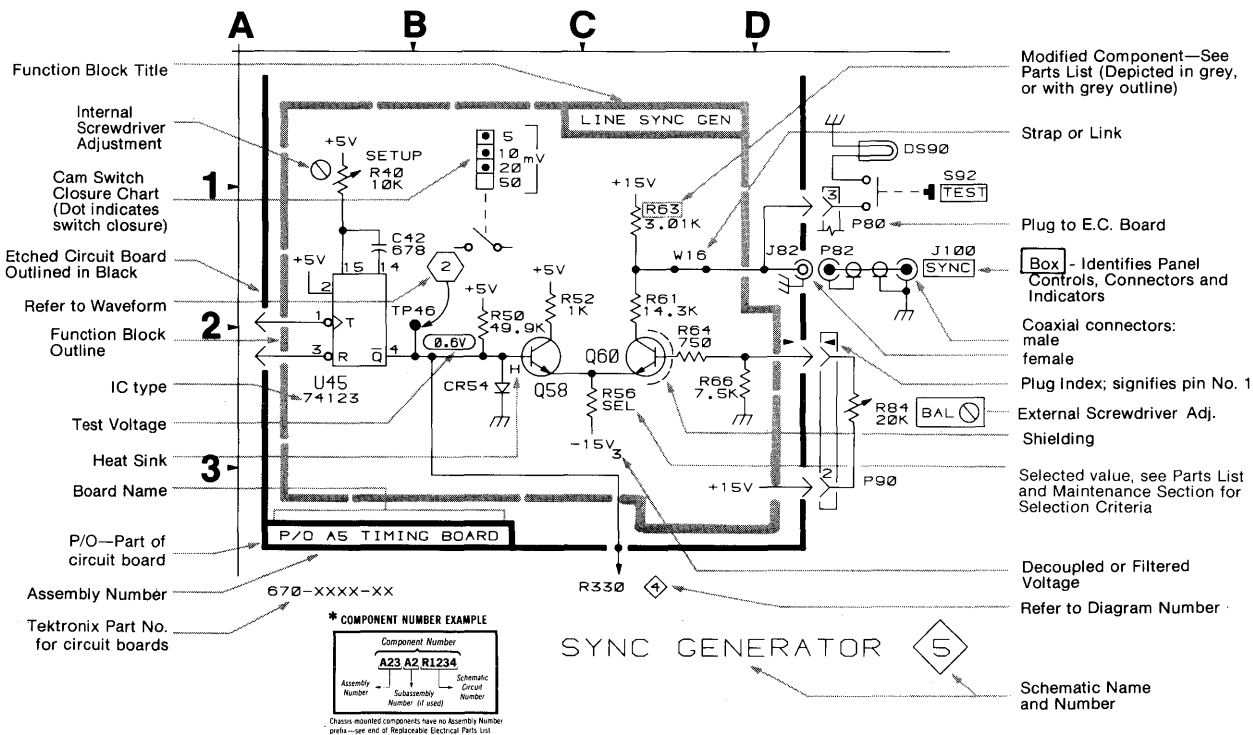
Resistors = Ohms (Ω).

———— The information and special symbols below may appear in this manual. ————

Assembly Numbers and Grid Coordinates

Each assembly in the instrument is assigned an assembly number (e.g., A20). The assembly number appears on the circuit board outline on the diagram, in the title for the circuit board component location illustration, and in the lookup table for the schematic diagram and corresponding component locator illustration. The Replaceable Electrical Parts list is arranged by assemblies in numerical sequence; the components are listed by component number *(see following illustration for constructing a component number).

The schematic diagram and circuit board component location illustration have grids. A lookup table with the grid coordinates is provided for ease of locating the component. Only the components illustrated on the facing diagram are listed in the lookup table. When more than one schematic diagram is used to illustrate the circuitry on a circuit board, the circuit board illustration may only appear opposite the first diagram on which it was illustrated; the lookup table will list the diagram number of other diagrams that the circuitry of the circuit board appears on.



ADJUSTMENT LOCATIONS AND SETUPS

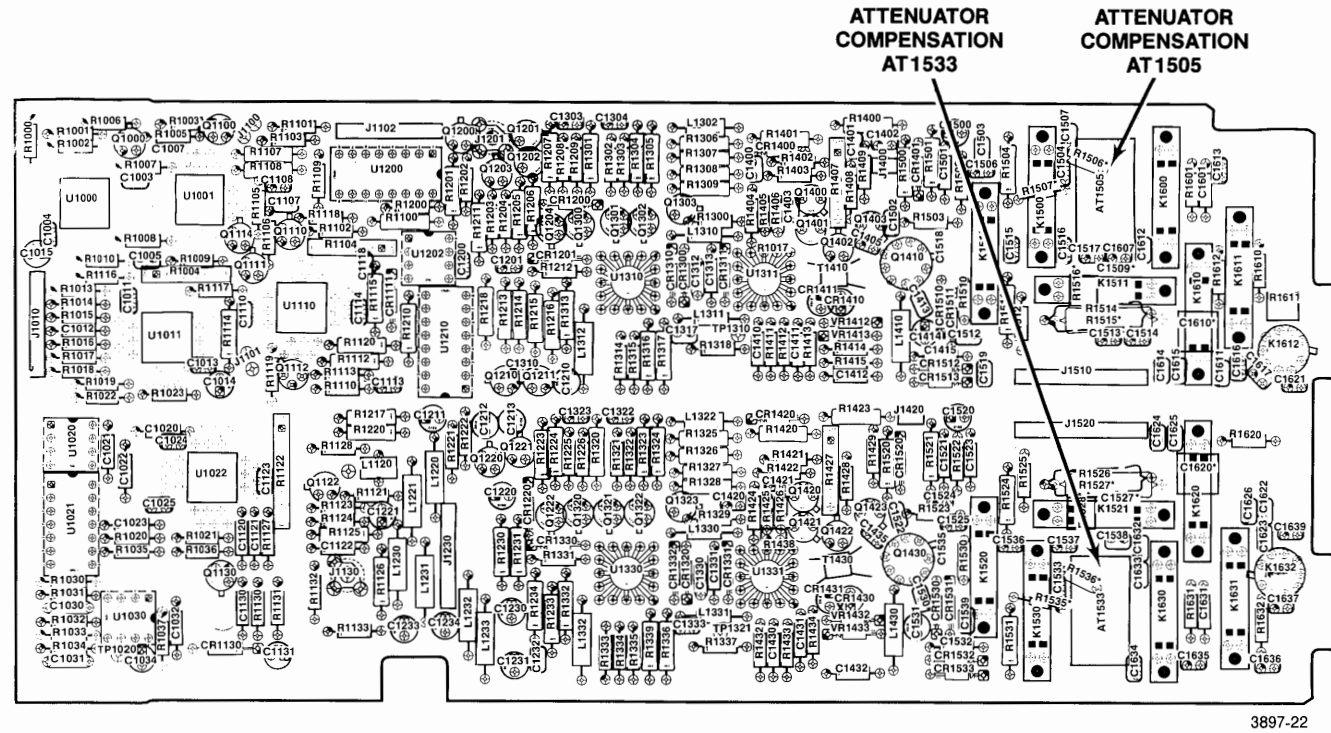


Fig. 8-1. Analog Board (A12).

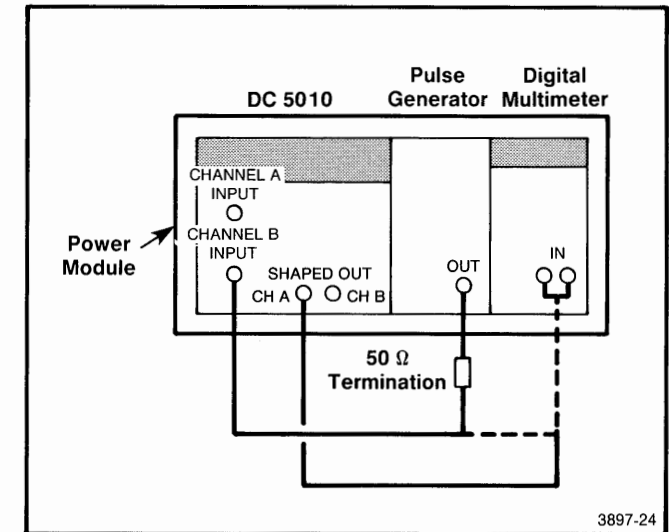


Fig. 8-3. Adjustment setup for steps 10 and 11.

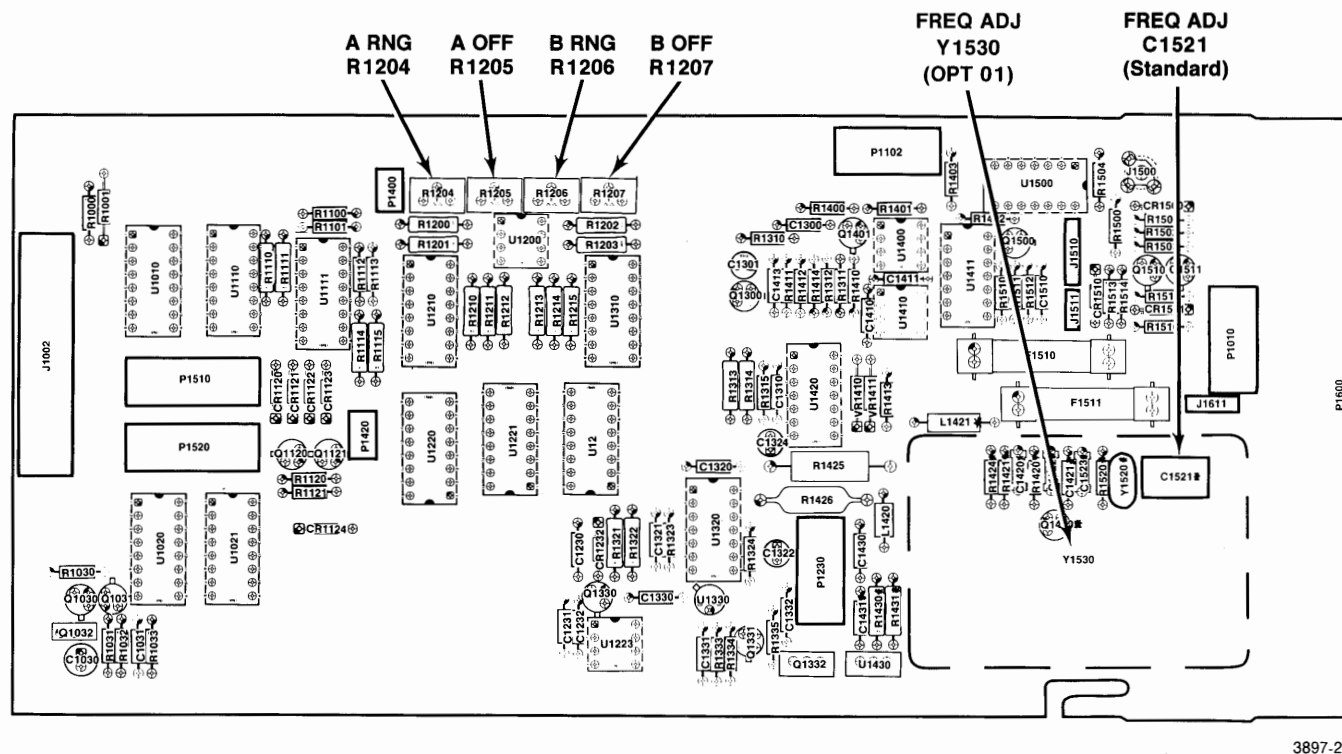


Fig. 8-2. Auxiliary Board (A18).

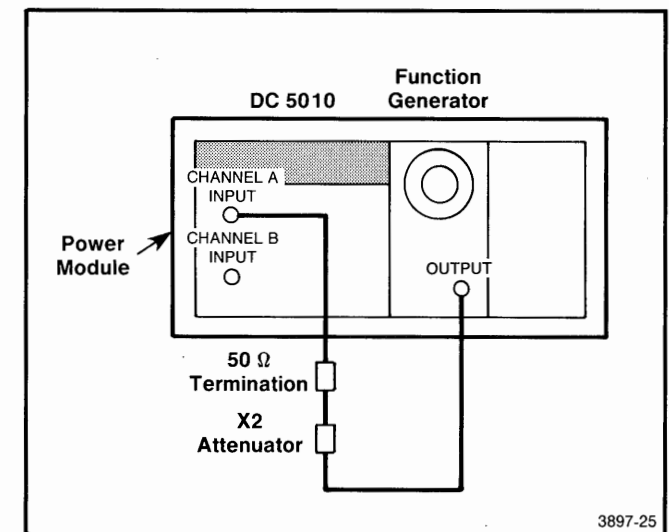


Fig. 8-4. Adjustment setup for steps 12 and 13.

Table 8-1
GENERAL PROBLEMS

PROBLEM	SUSPECT CIRCUITRY
MEASUREMENTS ARE STABLE BUT NOT ACCURATE.	TIME BASE OSCILLATOR (+18V SUPPLY FOR OPT. 1), BUFFER - Q1500, DIVIDER - U1411, AND PHASE LOCKED LOOP COMPONENTS OR JUMPERS J1511 OR J1515 LOOSE.
DOES NOT TRIGGER PROPERLY (MAY BE INDICATED BY INCORRECT SHAPED OUTPUTS).	DUAL DMOS IN AMPLIFIER , +12V, -12V, -5V, +5V ₂ SUPPLIES , AMPLIFIER COMPONENTS , .
INPUT CONDITIONING DOES NOT FUNCTION PROPERLY.	SWITCH , , RELAYS , RELAY DRIVERS , U1520E
DISPLAY DOES NOT FUNCTION PROPERLY.	DISPLAY CIRCUITRY ,
AUTO TRIGGER DOES NOT FUNCTION PROPERLY.	+2.5V SUPPLY , D/A CONVERTERS - U1210, U1310 , SERIAL-TO-PARALLEL SHIFT REGISTERS - U1222, U1220, U1221 , INPUT AMPLIFIERS , , BUFFERS - U1200 .
MEASUREMENTS WITH LOW FREQUENCY INPUT SIGNAL ARE NOT STABLE.	END SIGNAL , SUSPECT U1102C, U1410 , SCHMITT TRIGGERS, AMPLIFIERS , .
GATE LIGHT ALWAYS ON. NO MEASUREMENT COMPLETED.	END SIGNAL , SUSPECT U1102C, U1410 .
	ARM STUCK LOW: Q1510, Q1511

@

Table 8-2
COUNTER INTEGRITY ERRORS

ERROR CODE	SUSPECT CIRCUITRY
320	1. CHECK THAT INPUT SIGNAL IS WITHIN TRIGGER LEVEL RANGE, OR NO INPUT. 2. MAKE SURE ARM INPUT IS HIGH. 3. CHECK +12V, -12V, -5V. 4. SUSPECT FET Q1410, CHECK FOR SIGNAL ON T1418 5. CHECK MR AND MR LINES. 6. CHECK CH A DAC. 7. CHECK CH A AMP. , 8. CHECK GATING. 9. CHECK INPUT TO ACCUMULATOR. 10. SUSPECT U1000A. 11. SUSPECT U1102B, U1121.
321	1. SUSPECT U1000A, U1011 2. SUSPECT U1710D, U1121
322	1. SUSPECT U1011A 2. CHECK CABLE W528 3. SUSPECT U1810A 4. SUSPECT U1710B, U1121
323	1. SUSPECT U1801A , LEVEL SHIFTER Q1702, Q1701 2. SUSPECT U1121
324	1. SUSPECT LEVEL SHIFTER Q1702, Q1701 2. SUSPECT U1120A 3. SUSPECT U1121
329	1. SUSPECT CABLE W528 OR ANY ACCUMULATOR CHIP
330	1. CHECK CH B DAC 2. CHECK CH B AMP , 3. CHECK FET Q1430 4. CHECK FOR SIGNAL ON T1430 5. CHECK GATING 6. CHECK INPUT TO ACCUMULATOR 7. SUSPECT U1011C 8. SUSPECT U1102A OR U1122
331	1. SUSPECT U1011C, U1011B 2. SUSPECT U1710C, U1122
332	1. SUSPECT U1011, OR CABLE W538 2. SUSPECT U1810B 3. SUSPECT U1103
333	1. SUSPECT U1810B, LEVEL SHIFTER Q1704, Q1703 2. SUSPECT U1122
334	1. SUSPECT LEVEL SHIFTER Q1704, Q1703 2. SUSPECT U1120B, U1122
339	1. SUSPECT CABLE W529 OR ANY ACCUMULATOR CHIP

DIAGNOSTIC PROCEDURES

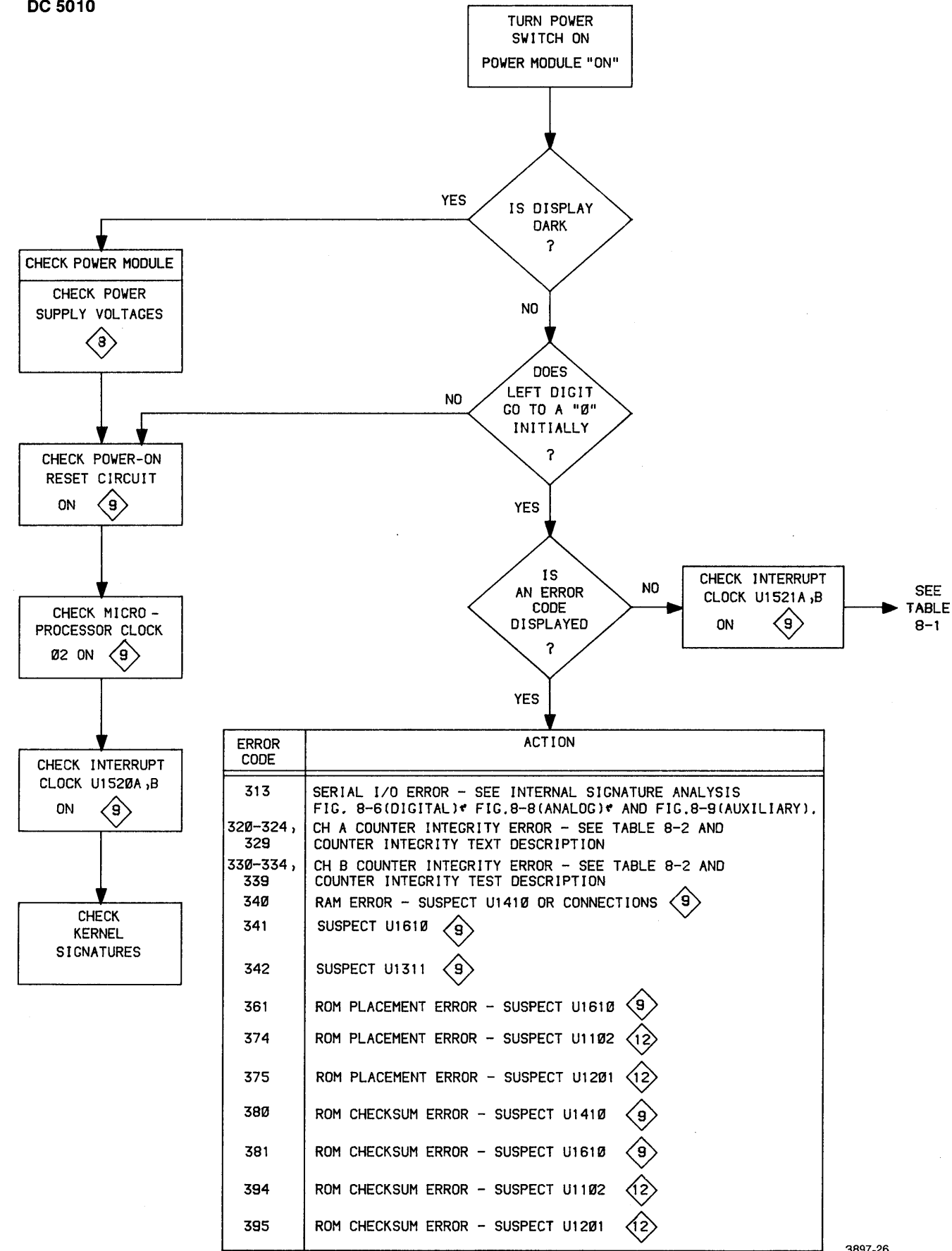


Fig. 8-5. General troubleshooting flow chart.

Serial path signatures

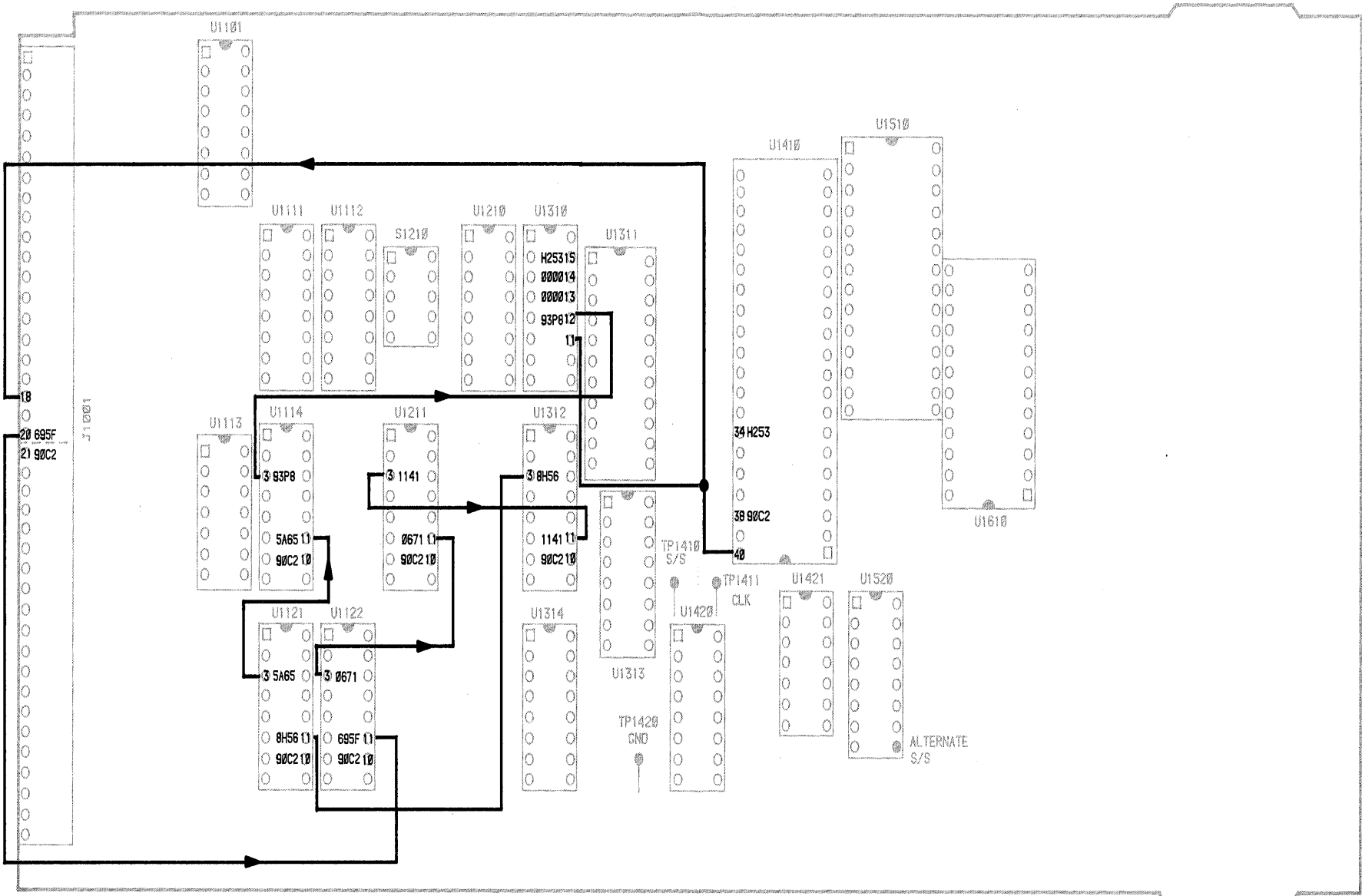


Fig. 8-6. Internal signature analysis "A" (Digital board).

+5V SIGNATURE = 47C6

3897-27

SETUP CONDITIONS

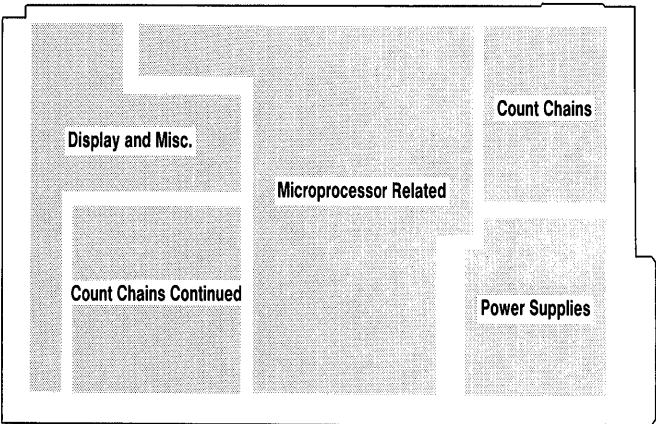
Internal Signatures (Digital Board)

SA CLOCK TP 1411
SA START }
SA STOP } Pin 9 of U1520
SA GND TP 1420

NOTE

Power up DC 5010 while holding in CH A ATTN button to get signatures.

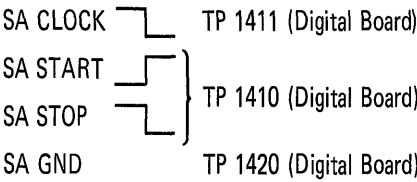
Address switch S1210 set to 20:



Digital board circuit locations

SETUP CONDITIONS

Internal Signatures (Digital Board)



NOTE

Power up DC 5010 while holding in CH A ATTEN button to get signatures.

Address switch S1210 set to 20:

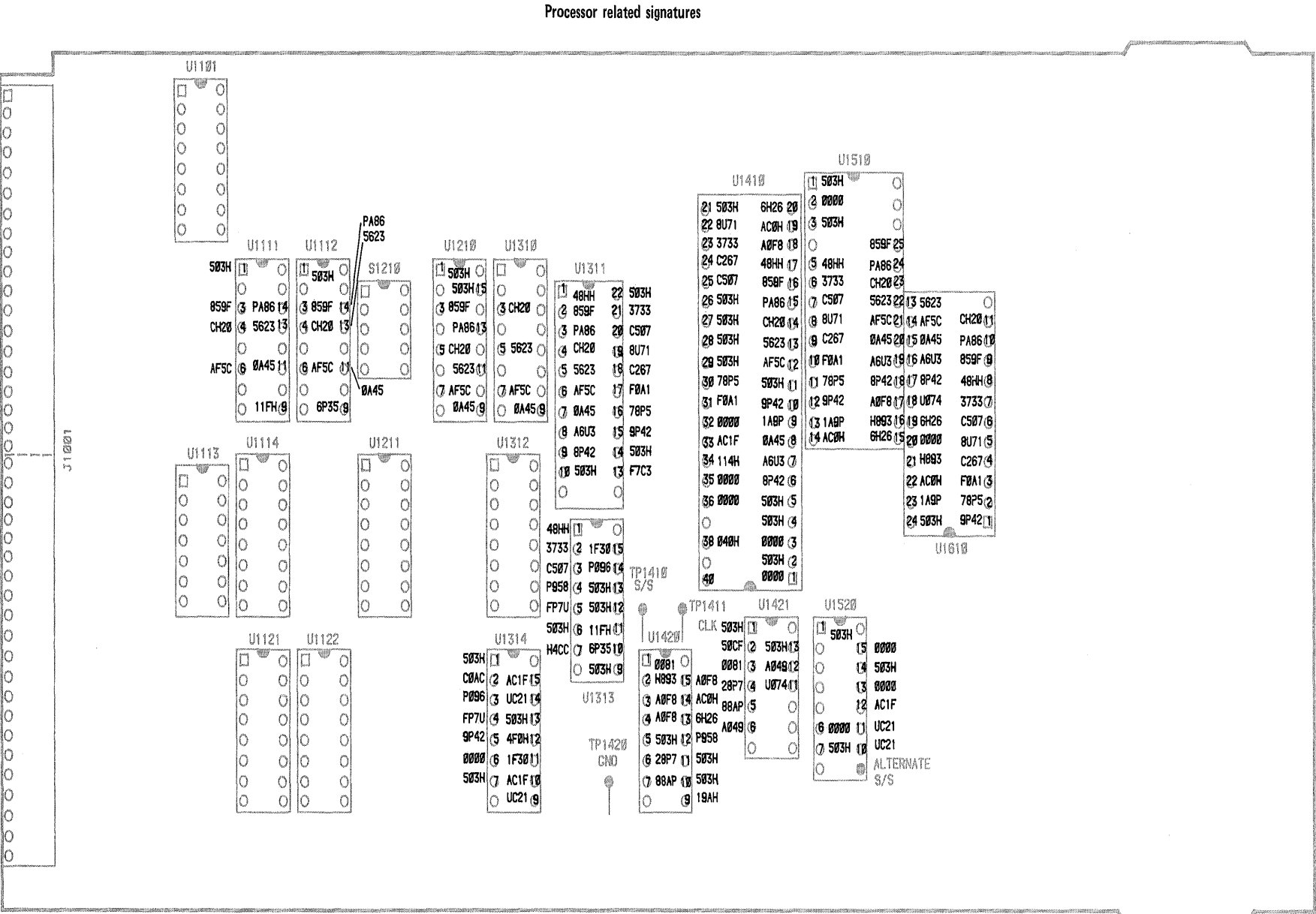
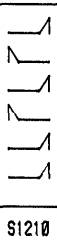


Fig. 8-7. Internal signature analysis "B" (Digital board).

+SV SIGNATURES = 503H

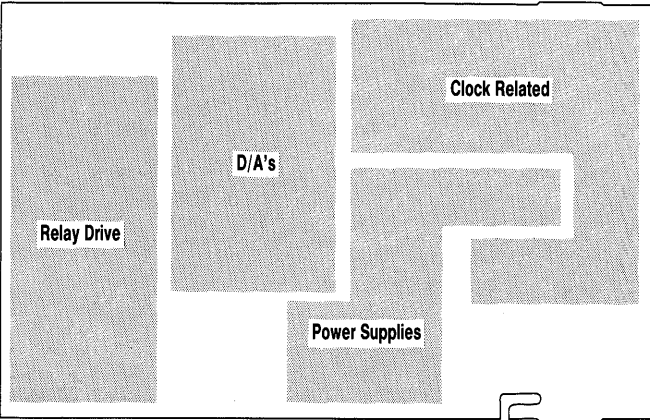
SETUP CONDITIONS

Internal Signatures (Auxiliary Board)

- SA CLOCK TP 1411 (Digital Board)
- SA START Pin 9 of U1520 (Digital Board)
- SA STOP Pin 9 of U1520 (Digital Board)
- SA GND TP 1420 (Digital Board)

NOTE

Power up DC 5010 while holding in CH A ATTEN button to get signatures.



Auxiliary board circuit locations

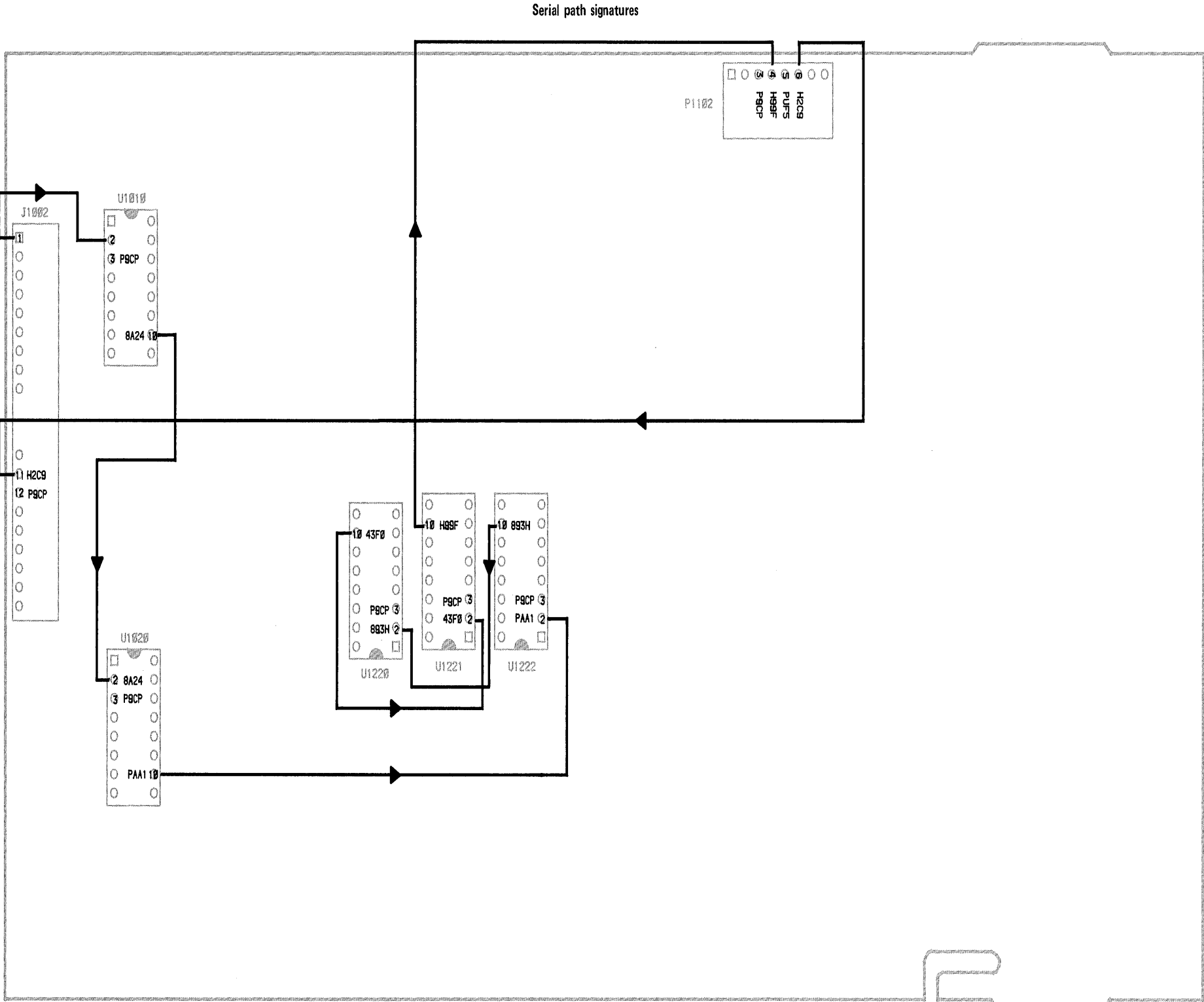
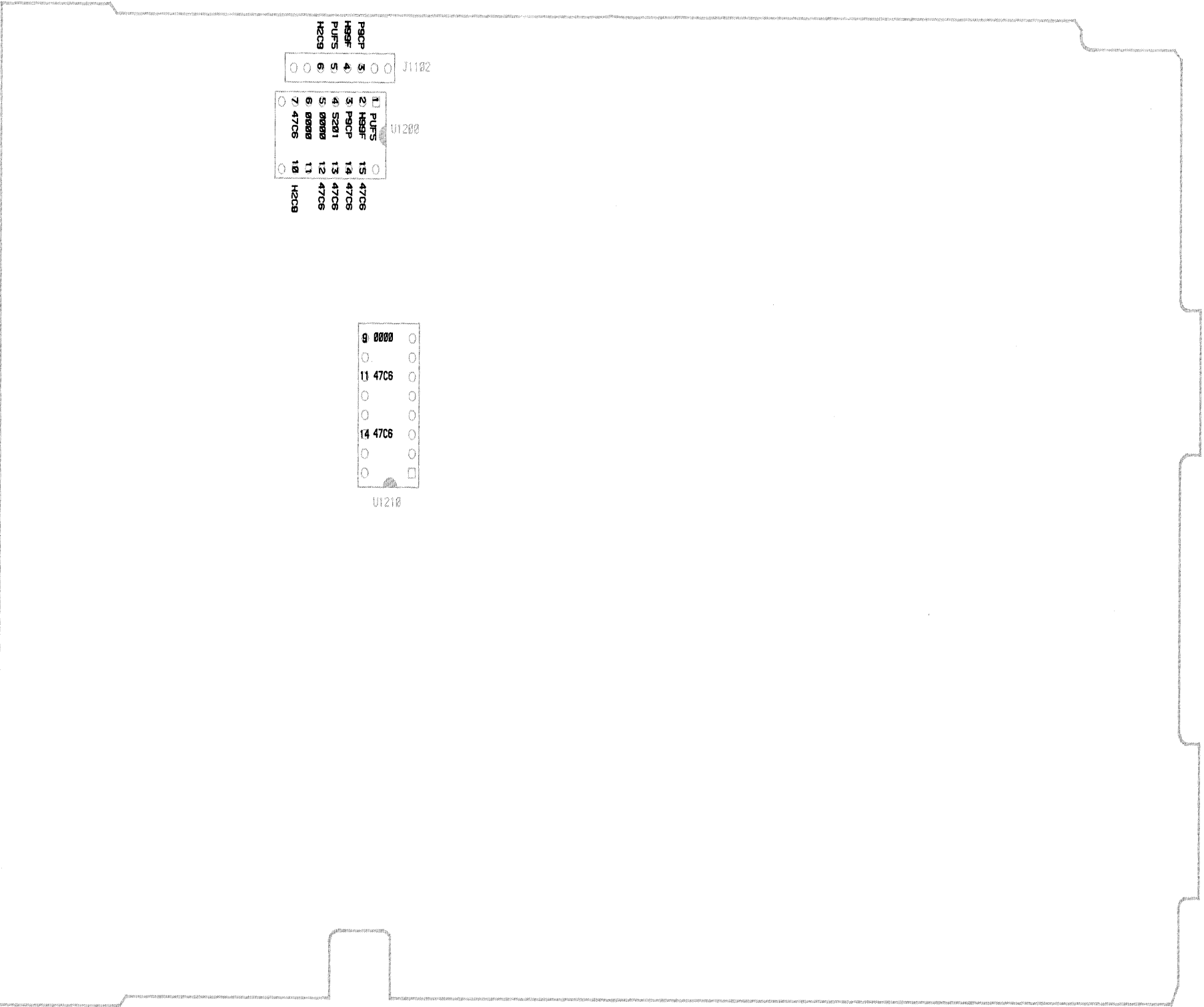


Fig. 8-9. Internal signature analysis (Auxiliary board).

+5V SIGNATURE = 47C6

Serial path signatures



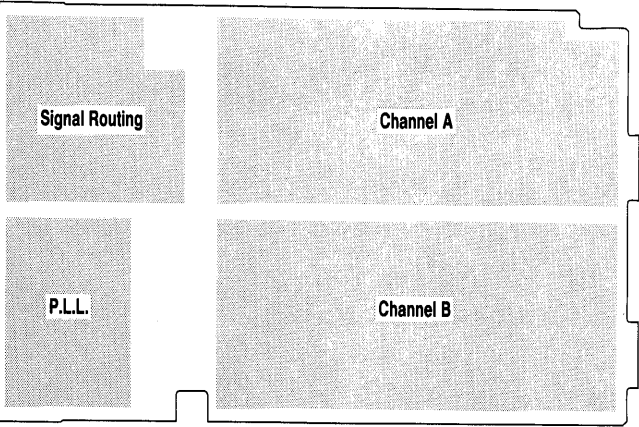
SETUP CONDITIONS

Internal Signatures (Analog Board)

SA CLOCK	TP 1411 (Digital Board)
SA START	Pin 9 of U1520 (Digital Board)
SA STOP	
SA GND	TP 1420 (Digital Board)

NOTE

Power up DC 5010 while holding CH A ATTEN button to get signature analysis.



Analog board circuit locations

Fig. 8-8. Internal signature analysis (Analog board).

+5V SIGNATURE = 47C6

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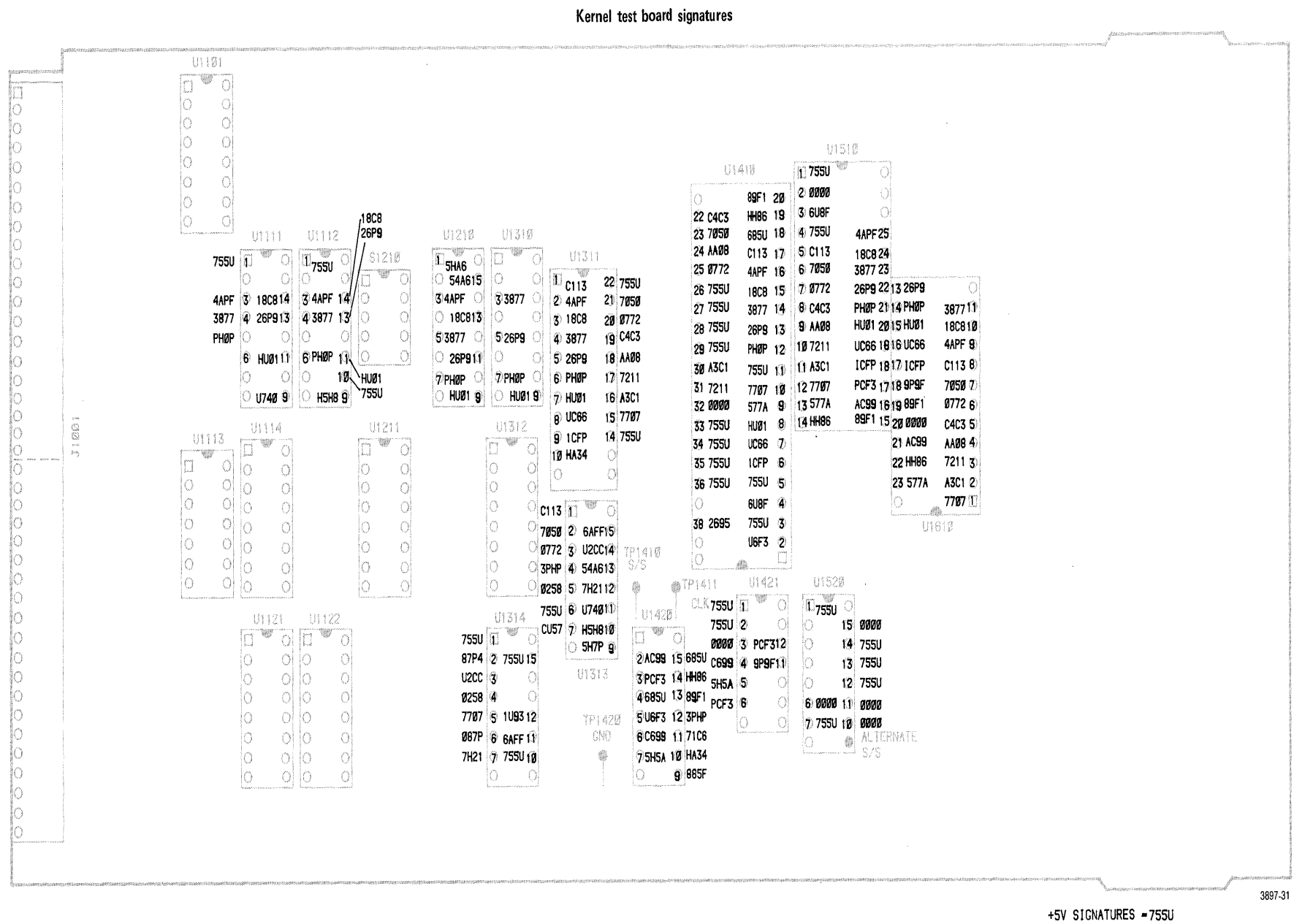


Fig. 8-10. Kernel signature analysis (Digital board).

SETUP CONDITIONS

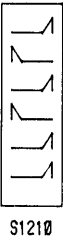
Kernel Test Signatures (Digital Board)

SA CLOCK	TP 1411 (Digital Board)
SA START	START/STOP (Kernel Board)
SA STOP	
SA GND	TP 1420 (Digital Board)

NOTE

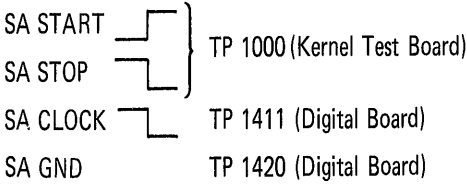
Power up DC 5010 while holding in CH A ATTN button to get signatures.

Address switch S1210 set to 20:



+5V SIGNATURES - 755U

SETUP CONDITIONS



NOTE

The microprocessor must be removed before making the Kernel test.

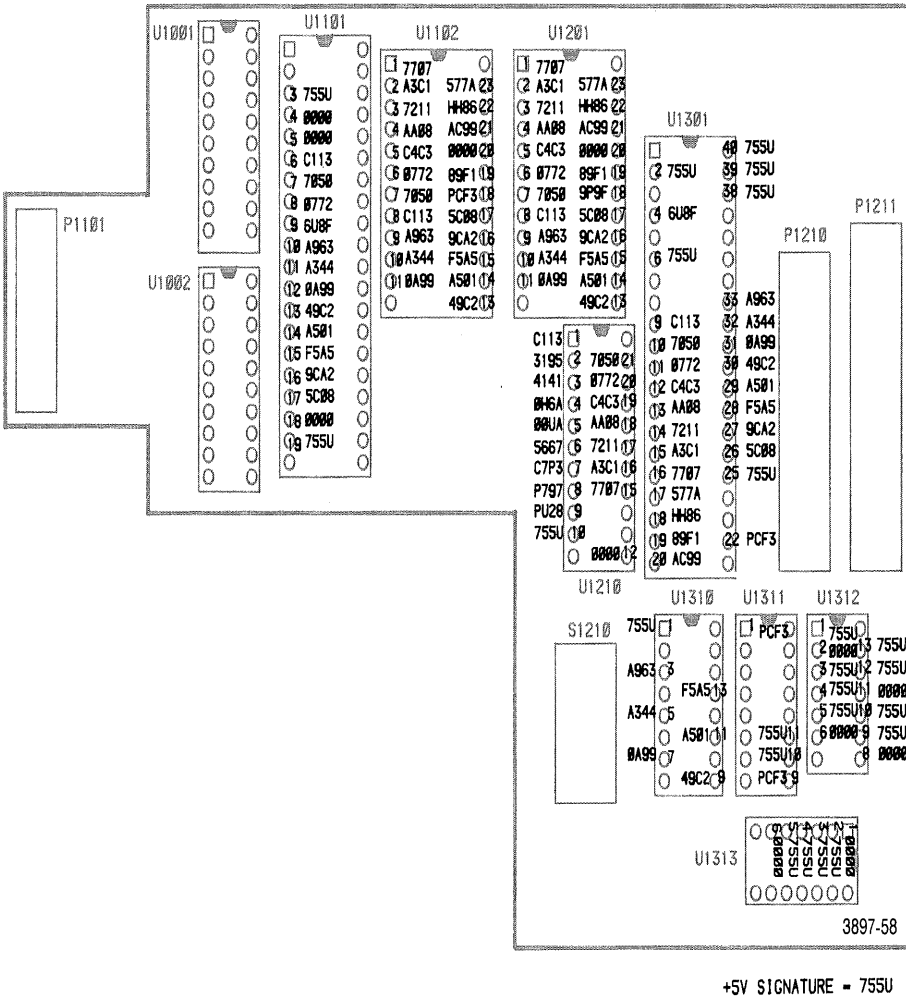
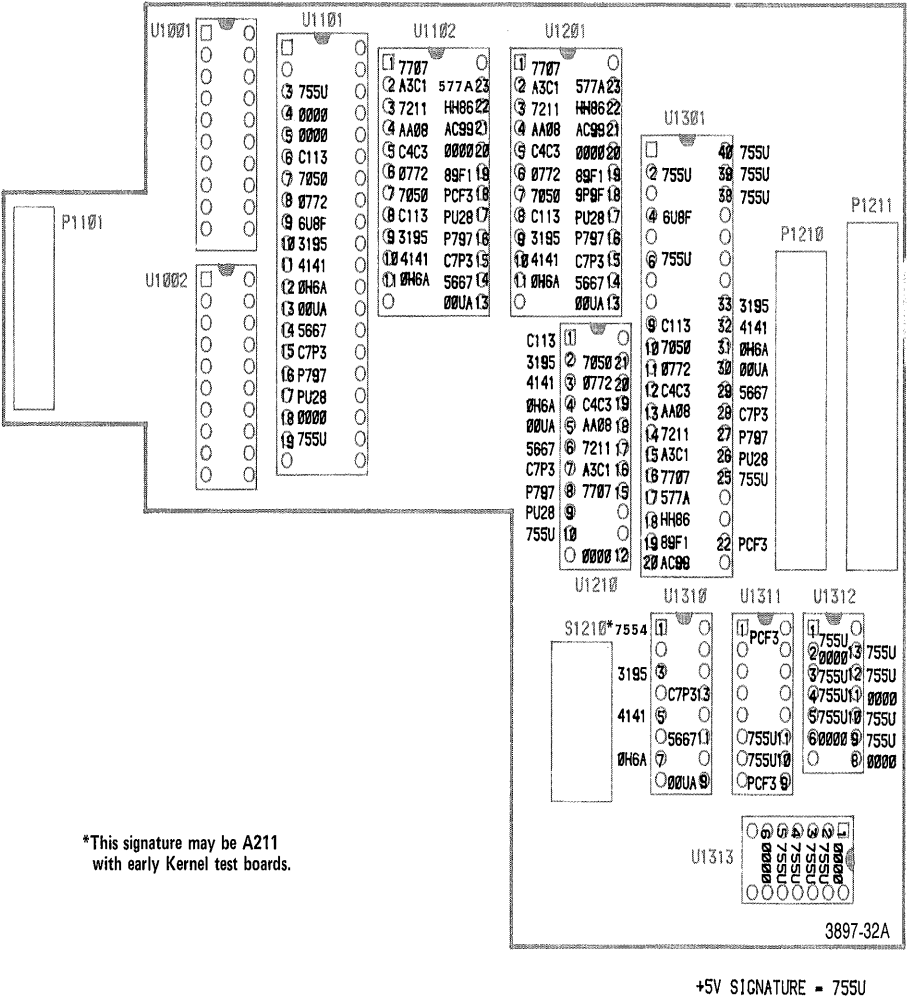


Fig. 8-11A. Kernel signature analysis (GPIB board) (SN B030000 & up).



*This signature may be A211 with early Kernel test boards.

Fig. 8-11B. Kernel signature analysis (GPIB board) (SN B029999 & below).

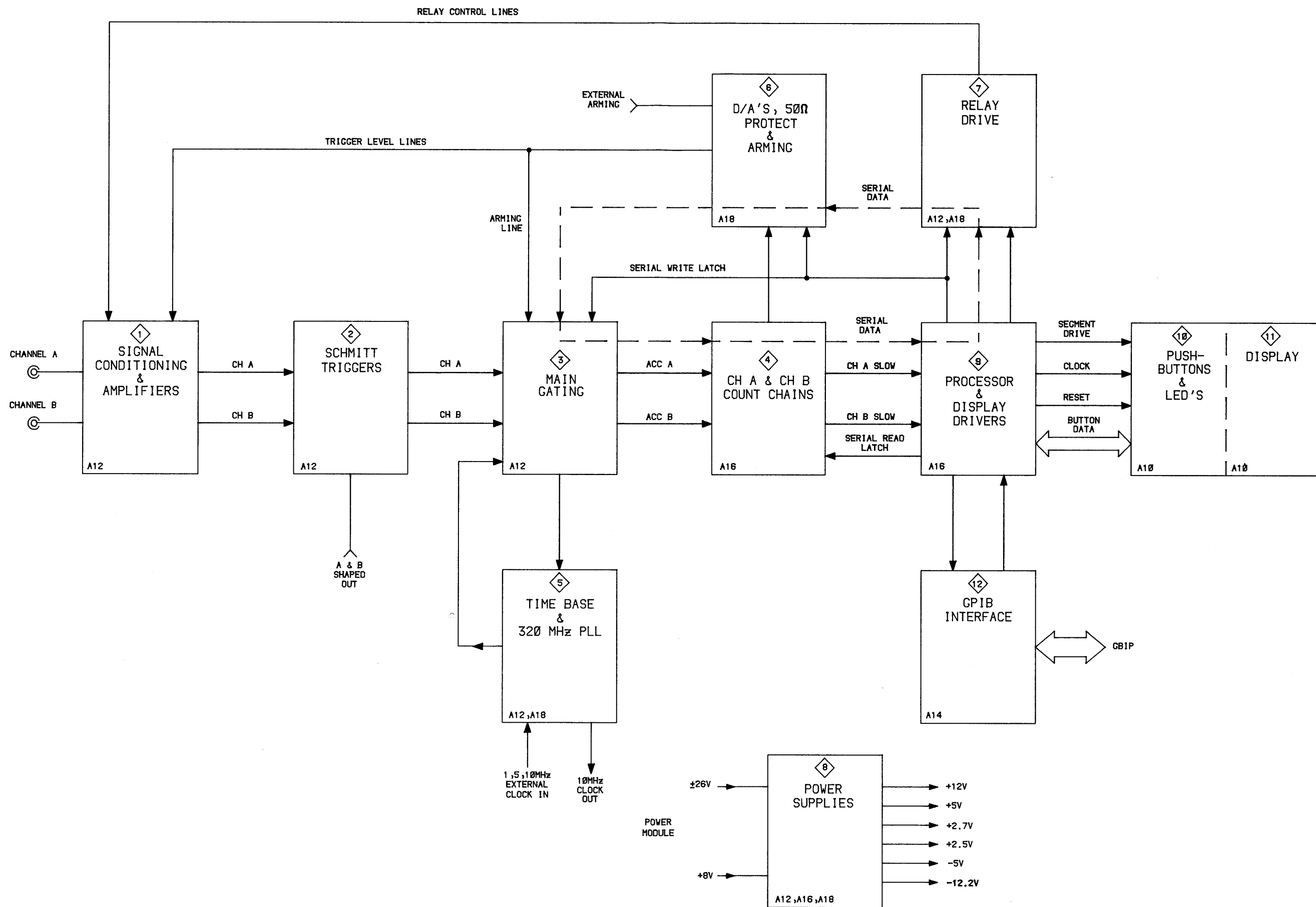


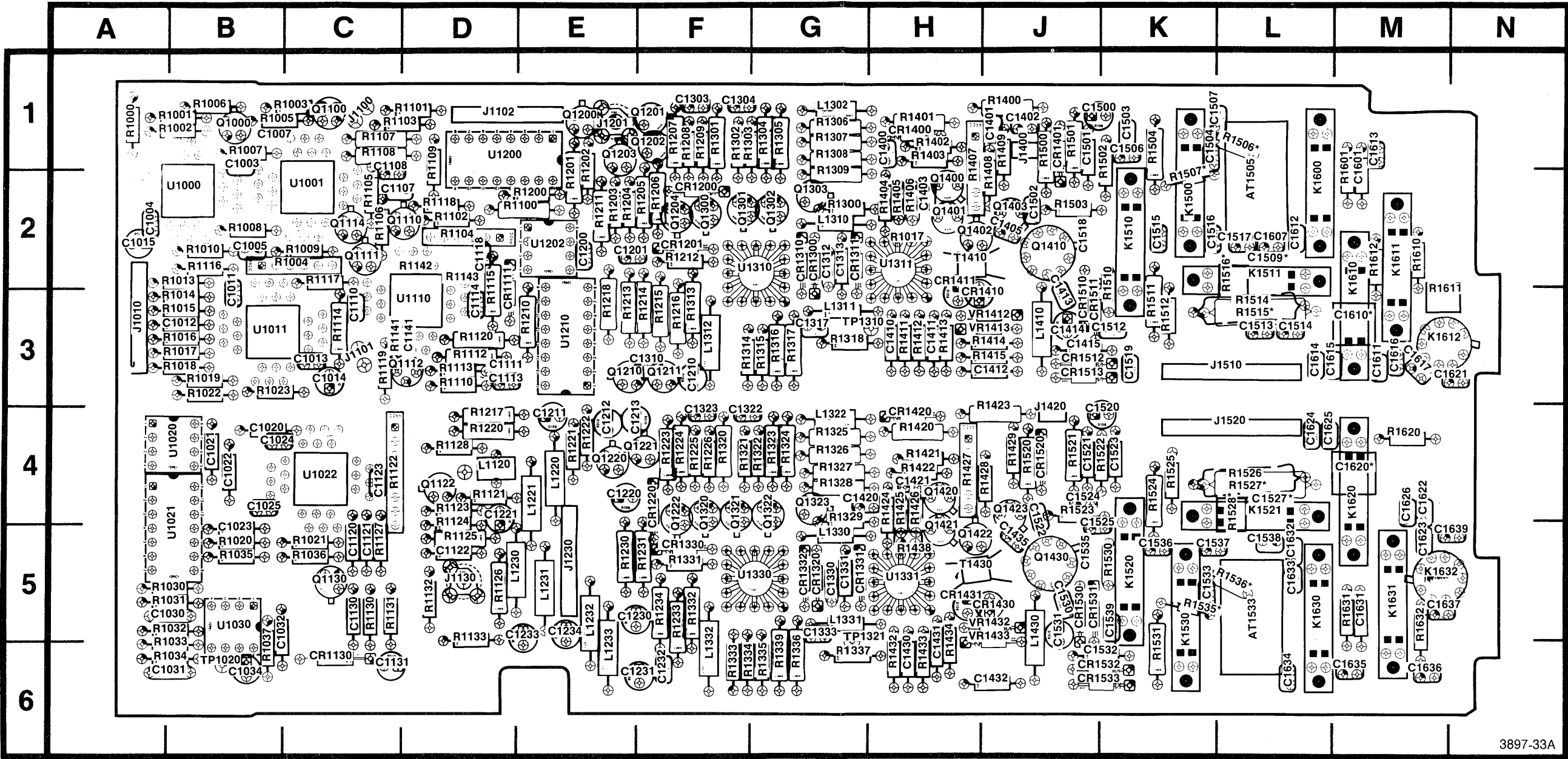
Table 8-3
COMPONENT REFERENCE CHART
(see Fig. 8-12)

P/O A12 ASSY			SIGNAL CONDITIONING & AMPLIFIERS 1					
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
AT1505	E3	L2	CR1532	G6	K6	R1421	K8	H4
AT1533	E7	L5	CR1533	H5	K6	R1422	K8	H4
						R1423	L9	J4
C1312	M3	G2	J1400	B4	J1	R1424	L8	H4
C1313	L3	G2	J1420	B8	J4	R1425	K8	H4
C1330	M7	G5	J500	B2	Chassis	R1426	J8	H4
C1331	L7	G5	J510	B6	Chassis	R1427	K9	H4
C1401	I4	J1				R1428	I8	J4
C1403	K4	H2	K1500S	F4	K2	R1429	J8	J4
C1405	H3	J2	K1510S	G2	K2	R1432	K6	H6
C1412	I1	J3	K1511S	E1	L2	R1433	K6	H6
C1413	I2	J3	K1520S	G6	K5	R1434	J6	H6
C1414	I2	J3	K1521S	E6	L4	R1438	K8	H5
C1415	F1	J3	K1530S	F8	K5	R1500	J4	J1
C1425	K8	H4	K1600S	D4	L2	R1501	J3	J1
C1432	I5	J6	K1610S	D1	M2	R1502	D4	K1
C1435	H7	J5	K1611S	C2	M2	R1503	G4	J2
C1500	I5	J1	K1612S	B2	M3	R1504	F3	K1
C1501	G4	J1	K1620S	D6	M4	R1506	E4	L1
C1502*	H3	J2	K1630S	D8	L5	R1507	E3	K2
C1503	J5	K1	K1631S	C6	M5	R1510	G2	K2
C1504	E3	K1	K1632S	C7	M5	R1511	F2	K3
C1509	E2	L2				R1512	F2	K3
C1518	G2	J2	L1310	M2	G2	R1514	D2	L3
C1520	K9	J4	L1311	M3	G3	R1515	E2	L3
C1521	G8	J4	L1330	M6	G5	R1516	E2	L2
C1522	H7	J4	L1331	M7	G5	R1520	J8	J4
C1523	I9	K4	L1410	I2	J3	R1521	J8	J4
C1527	E7	L4	L1430	I6	J5	R1522	D8	K4
C1530	I6	J5				R1523	G8	J4
C1531	I6	J5	Q1210	K1	E3	R1524	F6	K4
C1532	F6	K6	Q1211	K1	F3	R1525	F6	K4
C1533	E7	K5	Q1400	J4	H2	R1526	E6	L4
C1535	G6	J5	Q1401	K4	H2	R1527	D6	L4
C1601	C3	M1	Q1402	H4	H2	R1528	E7	L4
C1610	D3	M3	Q1403	I4	J2	R1530	G6	K5
C1620	D7	M4	Q1410	H2	J2	R1531	F7	K6
C1631	C7	M5	Q1420	J8	H4	R1535	E7	K5
			Q1421	K8	H5	R1536	E8	L5
CR1300	M3	G2	Q1422	H8	H5	R1601	D4	M1
CR1310	M2	G2	Q1423	I8	G2	R1610	C3	M2
CR1311	L3	G2	Q1430	H6	J5	R1611	B2	M3
CR1320	M7	G5				R1612	C2	M2
CR1331	L7	G5	R1318	K2	G3	R1620	C6	M4
CR1332	M7	G5	R1337	K6	G6	R1631	D8	M5
CR1400	L5	H1	R1400	M4	J1	R1632	C7	M5
CR1401	J4	J1	R1401	L4	H1			
CR1410	J2	H2	R1402	K4	H1	T1410	J2	H2
CR1411	I2	H2	R1403	K4	H1	T1430	J7	H5
CR1420	L9	H4	R1404	L3	H2	TP1310	M3	G3
CR1430	J7	J5	R1405	K4	H2	TP1321	M7	G5
CR1431	I7	H5	R1406	J4	H2			
CR1510	G1	J3	R1408	I4	J1	U1311	J3	H2
CR1511	H1	J3	R1409	I4	J1	U1331	J7	H5
CR1512	G1	J3	R1411	K2	H3			
CR1513	H1	J3	R1412	K2	H3	VR1412	I3	J3
CR1520	J9	J4	R1413	J2	H3	VR1413	J3	J3
CR1530	G5	J5	R1417	K3	H2	VR1432	I7	J5
CR1531	H6	J5	R1420	L9	H4	VR1433	J7	J5

P/O A12 ASSY also shown on



PARTS LOCATION GRID



3897-33A

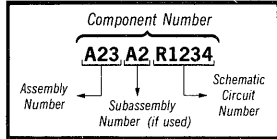
A12

Fig. 8-12. Analog board (A12).

Static Sensitive Devices
See Maintenance Section

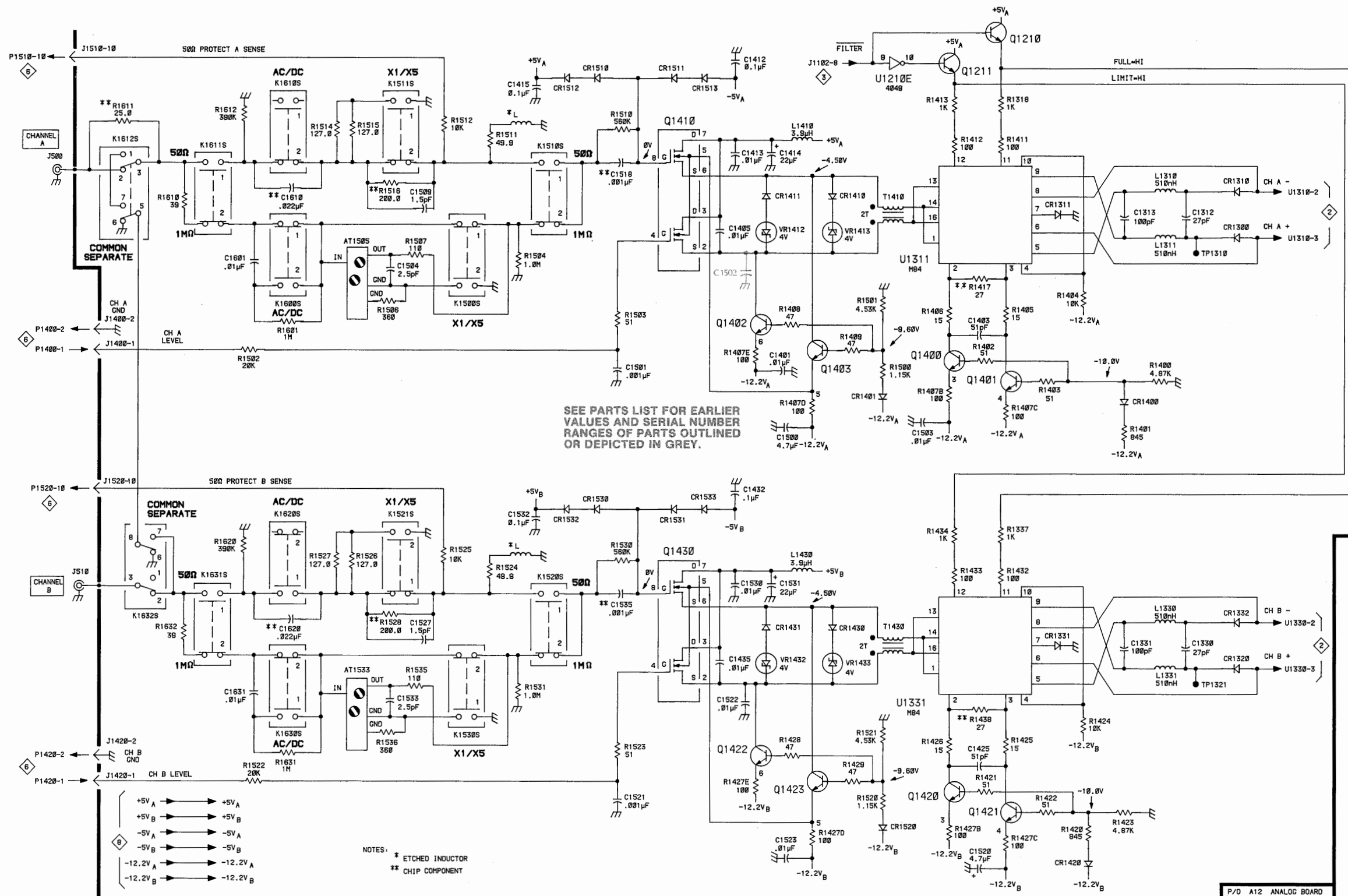
* Located on back of board.

COMPONENT NUMBER EXAMPLE



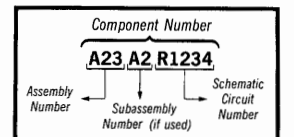
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

A | B | C | D | E | F | G | H | I | J | K | L | M | N



Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Table 8-4

COMPONENT REFERENCE CHART

(see Fig. 8-12)

P/O A12 ASSY			SCHMITT TRIGGERS 2		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1108	F5	C2	R1204	C5	E2
C1111*	F5	D3	R1205	C5	F2
C1113	F10	D3	R1206	J4	F2
C1122	B9	D5	R1207	J4	F1
C1200	B4	E2	R1208	H4	F1
C1201	J2	E2	R1209	E4	F1
C1210	J2	F3	R1211	G5	E2
C1230	J7	E5	R1212	H2	F2
C1303	H3	F1	R1213	I3	E3
C1304	G3	F1	R1214	H3	F3
C1317	H1	G3	R1215	I2	F3
C1319	G2	G2	R1216	H2	F3
C1322	G8	F4	R1217	G10	D4
C1323	H8	F4	R1218	G5	E3
C1333	H6	G5	R1220	G10	D4
C1339	G7	G5	R1222	J10	E4
CR1200	I3	F2	R1223	J9	F4
CR1201	I3	F2	R1224	J9	F4
CR1220	I8	F4	R1225	H9	F4
CR1330	I8	F5	R1226	E9	F4
J1130	B10	D5	R1230	I8	E5
J1201	B5	E1	R1231	H8	F5
J520	A5	Chassis	R1233	H7	F5
J530	A10	Chassis	R1234	I7	F5
L1302	H3	G1	R1300	F2	G2
L1312	J2	F3	R1301	G3	F1
L1322	H8	G4	R1302	D4	F1
L1332	J7	F6	R1303	F4	F1
P1130	B10	D5	R1304	F3	G1
P1201	B4	E1	R1305	I3	G1
Q1122	C9	D4	R1306	I4	G1
Q1201	I5	F1	R1307	E2	G1
Q1202	J4	F1	R1308	E3	G1
Q1203	C5	E1	R1309	E3	G2
Q1204	G4	F2	R1313	H2	F3
Q1220	J9	E4	R1314	G1	F3
Q1221	I10	F4	R1315	F1	G3
Q1222	G9	F4	R1316	H1	G3
Q1300	E4	F2	R1317	G1	G3
Q1301	D4	F2	R1319	G1	G3
Q1302	G4	G2	R1320	G8	F4
Q1303	E3	G2	R1321	D9	F4
Q1320	E9	F4	R1322	F9	G4
Q1321	D9	F4	R1323	F8	G4
Q1322	G9	G4	R1324	I8	G4
Q1323	F8	G4	R1325	I9	G4
R1107	F5	C1	R1326	E8	G4
R1108	G5	C1	R1327	E8	G4
R1112	F10	D3	R1328	E8	G4
R1118	G5	D2	R1329	F7	G4
R1120	G10	D3	R1331	H7	F5
R1121	D9	D4	R1332	H7	F5
R1123	C10	D4	R1333	G6	F6
R1124	C9	D4	R1334	F6	F6
R1125	C9	D5	R1335	H6	G6
R1126	C10	D5	R1336	G6	G6
R1128	G10	D4	R1339	G6	G6
R1200	J5	E2	R1407	H4	H1
R1201	C4	E1	U1202	H5	E2
R1202	C4	E1	U1210	J9	E3
R1203	D4	E2	U1310	F1	G2
			U1330	F7	G5
			W500	B5	Chassis
			W510	B10	Chassis

P/O A12 ASSY also shown on



PARTS LOCATION GRID

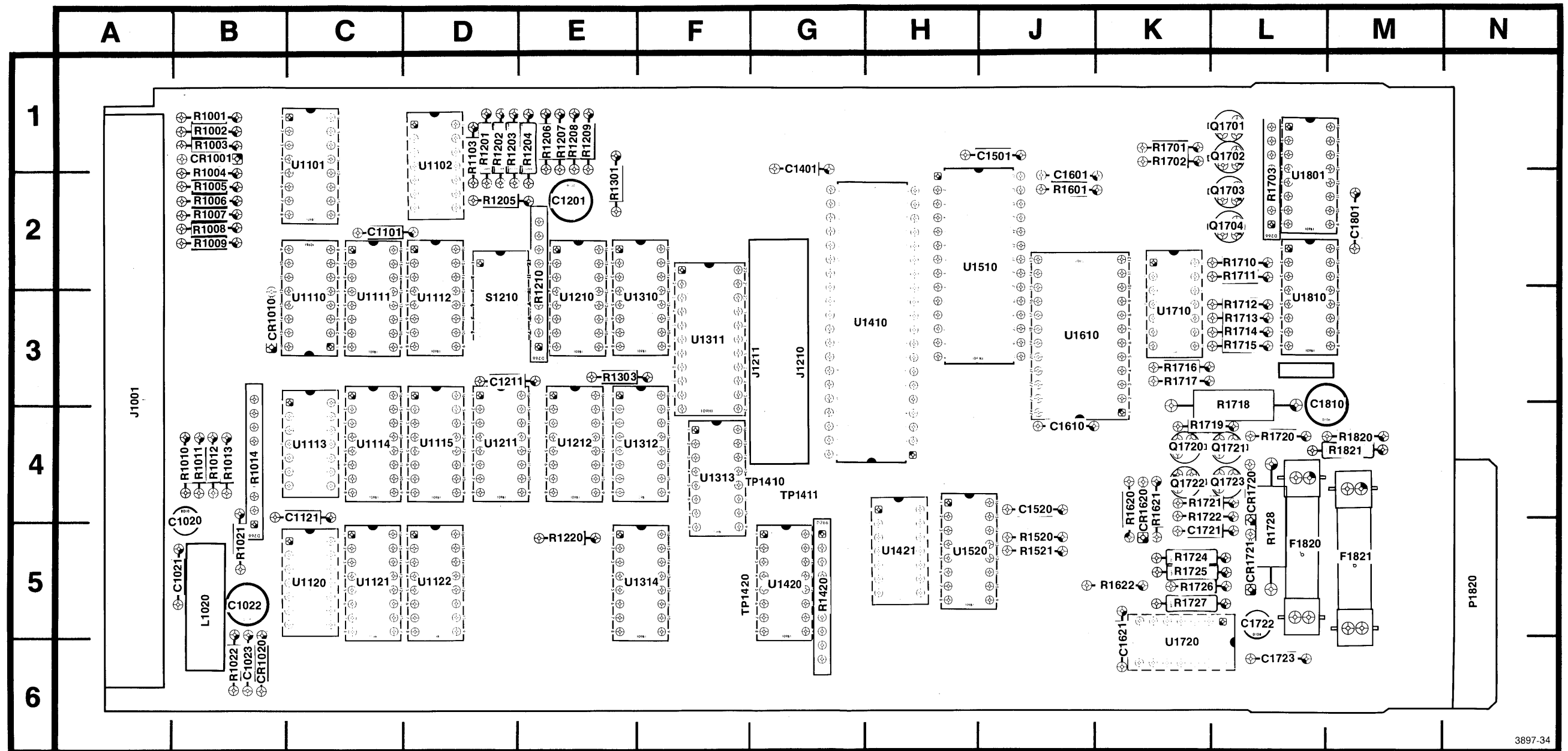


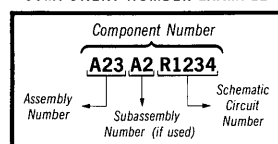
Fig. 8-13. Digital board (A 16).

897-34

A 16



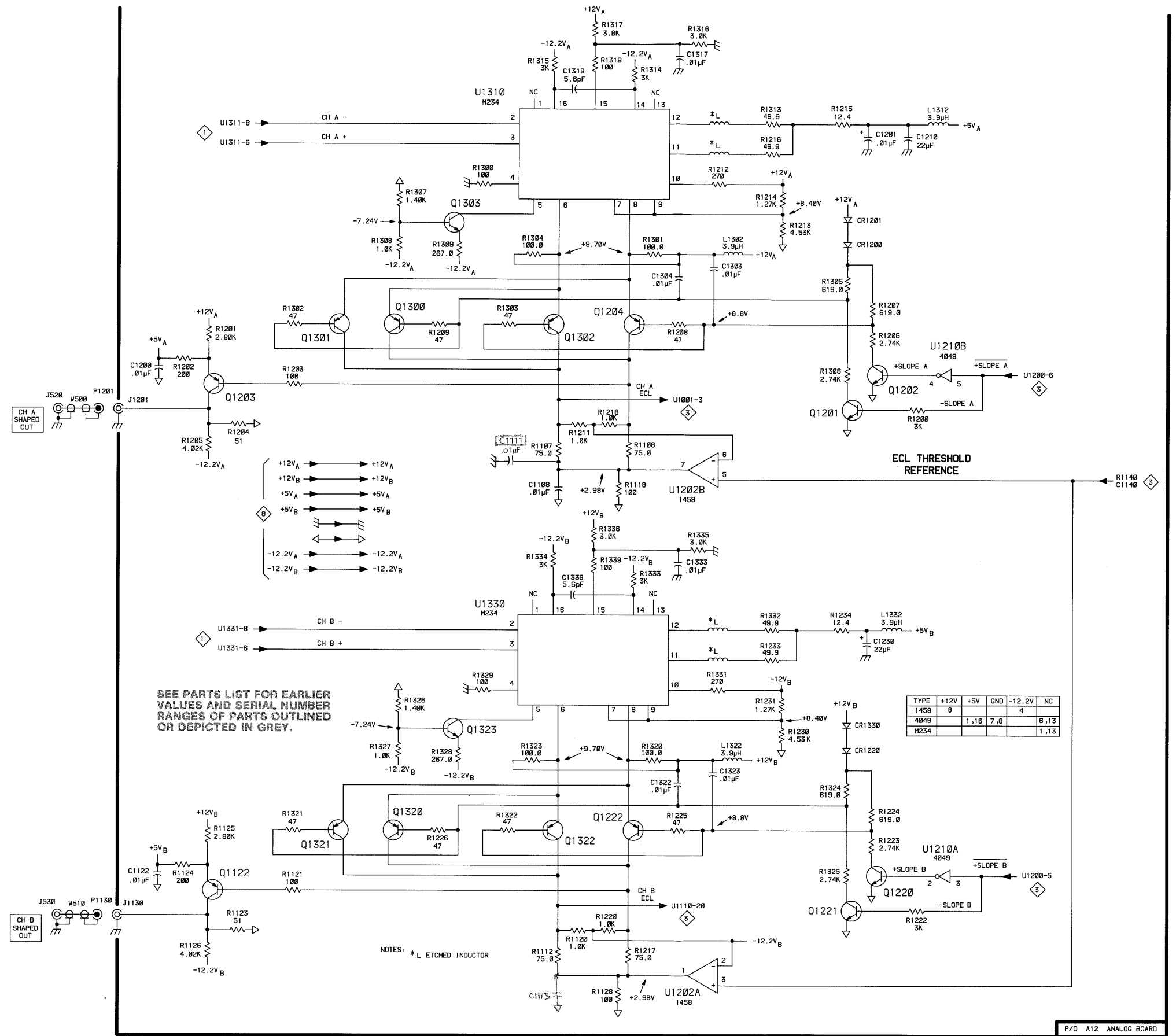
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

A | B | C | D | E | F | G | H | I | J | K | L

1
2
3
4
5
6
7
8
9
10



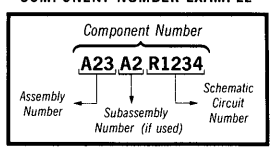
DC 5010

REV DEC 1982
3897-46

SCHMITT TRIGGERS

P/O A12 ANALOG BOARD

Static Sensitive Devices
See Maintenance Section
COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Table 8-5
COMPONENT REFERENCE CHART
(see Fig. 8-12 and 8-14)

P/O A12 ASSY			MAIN GATING 3		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION			
C1003	L7	B1	R1004	K2	C2
C1004	L8	A2	R1005	K3	B1
C1005	F3	B2	R1006	G4	B1
C1010*	J4	B2	R1007	E2	B1
C1011	O7	B3	R1008	L2	B2
C1012	M6	B3	R1009	J2	C2
C1013	N8	C3	R1010	J3	B2
C1014	N7	C3	R1013	M1	B2
C1015	I3	A2	R1014	M1	B3
C1107	L8	C2	R1015	N2	B3
C1110	O9	C3	R1016	M4	B3
C1114	N10	D3	R1017	M5	B3
C1118	K5	D2	R1018	O6	B3
C1140	I7	D3	R1019	N2	B3
C1141*	H6	D3	R1022	M6	B3
CR1111	H7	D2	R1023	N6	B3
			R1101	H8	D1
DL500	E4	Chassis	R1102	D3	D2
			R1103	F5	C1
J1010	N2	A3	R1104	C4	D2
J1102	B7	D1	R1105	D6	C2
			R1106	C6	C2
L1009	J2	C2	R1109	F3	D1
			R1110	F6	D3
Q1000	I3	B1	R1113	H7	D3
Q1100	F4	C1	R1116	M2	B2
Q1110	C3	C2	R1117	L6	C2
Q1111	C5	C2	R1119	H6	C3
Q1112	F5	D3	R1140	I7	D3
Q1114	D2	C2	R1141*	H7	D3
Q1200	F8	E1	R1142*	I6	D3
			R1143*	H7	D3
R1000	H3	A1	U1000	L8	B2
R1001	K4	B1	U1001	M8	C2
R1002	H3	B1	U1011	N8	B3
R1003	I4	C1	U1110	N9	D3
			U1200	C6	D1
			U1200	I8	D1
P/O A12 ASSY also shown on			1	2	5
			7	8	

PARTS LOCATION GRID

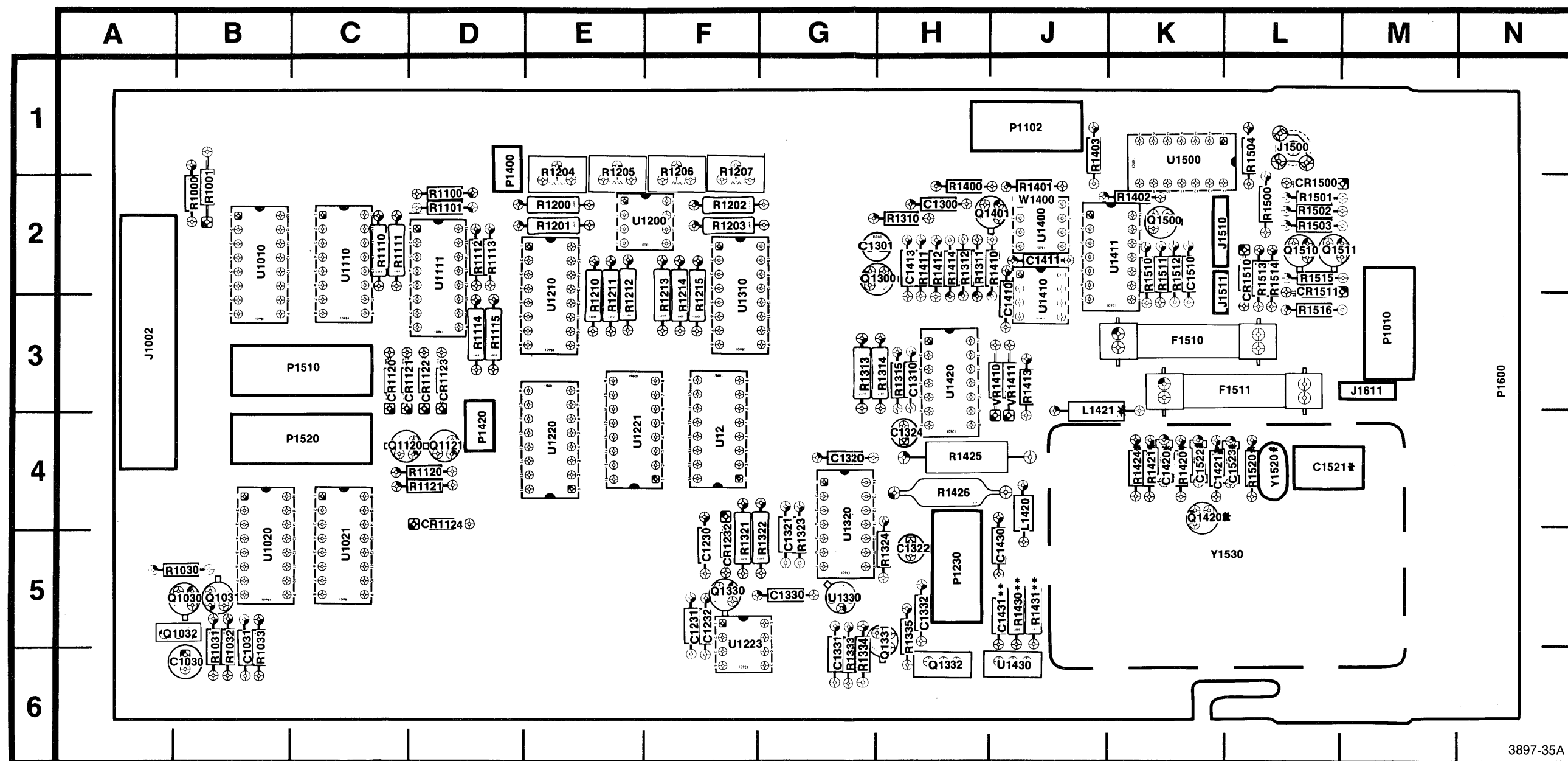


Fig. 8-14. Auxiliary board (A18).

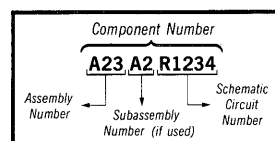
A18

 **Static Sensitive Devices**
See *Maintenance Section*

***Removed for Option 01**

****Added for Option 01**

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

REV JUL 1983



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

PARTS LOCATION GRIDS

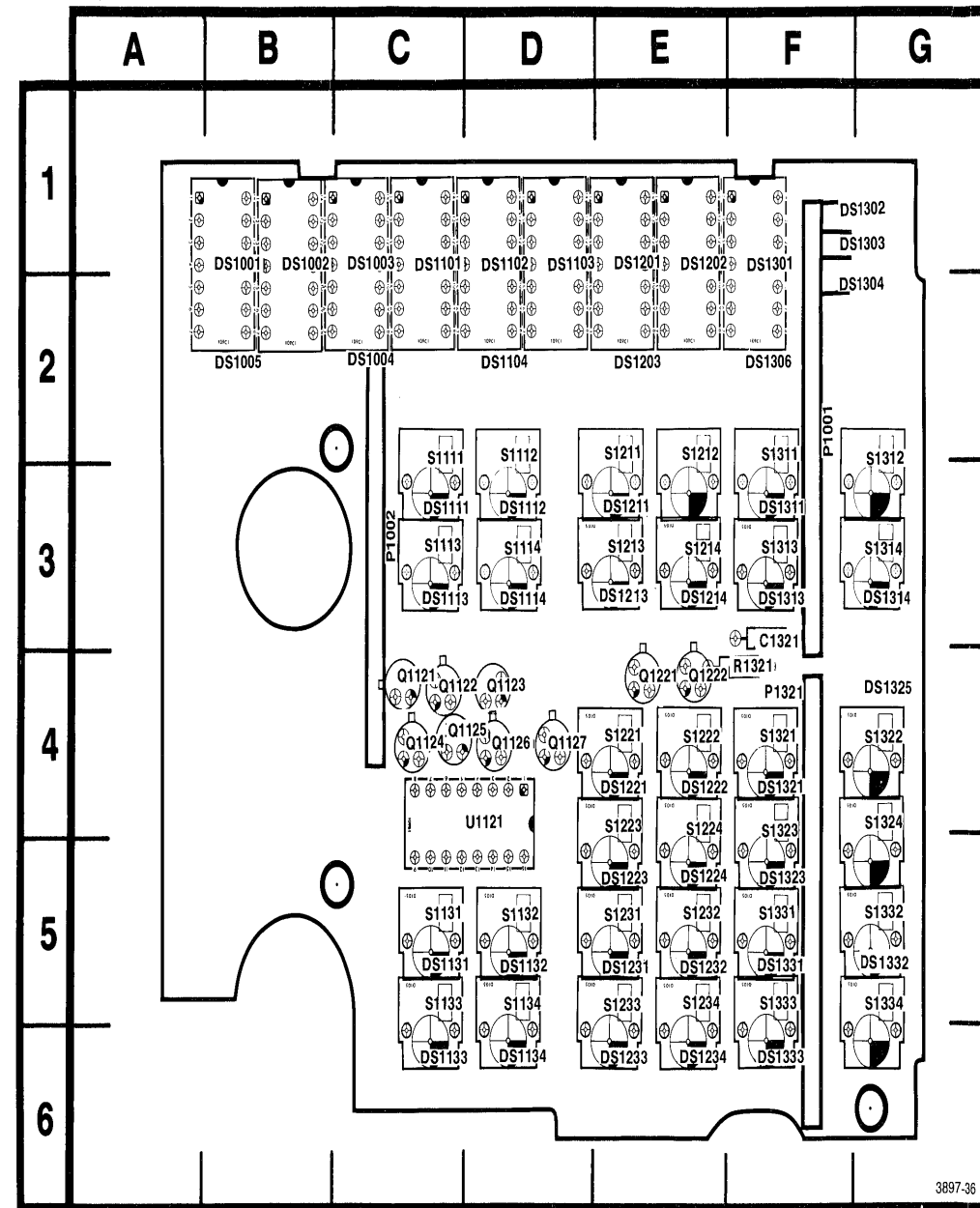


Fig. 8-15. Display board (A10).

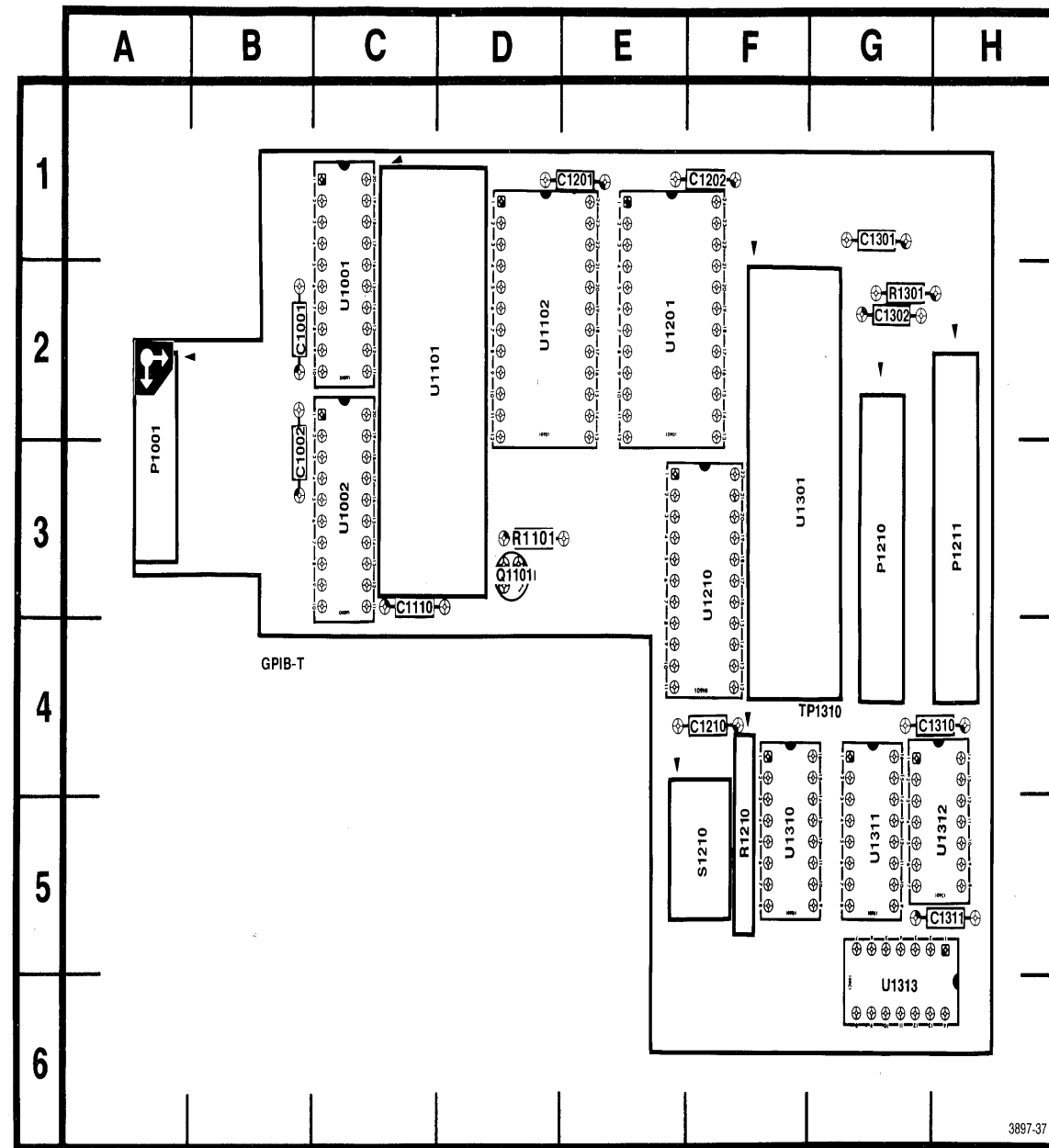




Fig. 8-16. GPIB board (A14).

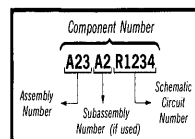
Table 8-6
COMPONENT REFERENCE CHART
(see Fig. 8-13)

P/O A16 ASSY			CH A & CH B COUNT CHAINS 		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1121	L8	C4	R1714	D2	L3
C1211	M8	D3	R1715	C7	L3
C1801	M8	M2	R1716	G3	K3
			R1717	F9	K3
Q1701	G2	L1			
Q1702	F2	L1	U1102	E4	D1
Q1703	G8	L2	U1113	J2	C4
Q1704	F8	L2	U1114	K4	C4
			U1115	K2	D4
R1014	I7	B4	U1120	H2	C5
R1021	H8	B5	U1121	G4	C5
R1207	E4	E1	U1122	G6	D5
R1208	E6	E1	U1211	I6	D4
R1209	E4	E1	U1212	L8	E4
R1701	G1	K1	U1312	L6	F4
R1702	F8	K1	U1710	E7	K3
R1703	E2	L2	U1801	E2	L2
R1710	D3	L2	U1810	D2	L3
R1711	C7	L2			
R1712	D7	L3	W520A	B2	Chassis
R1713	C2	L3	W530A	B8	Chassis

P/O A16 ASSY also shown on 

 **Static Sensitive Devices**
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

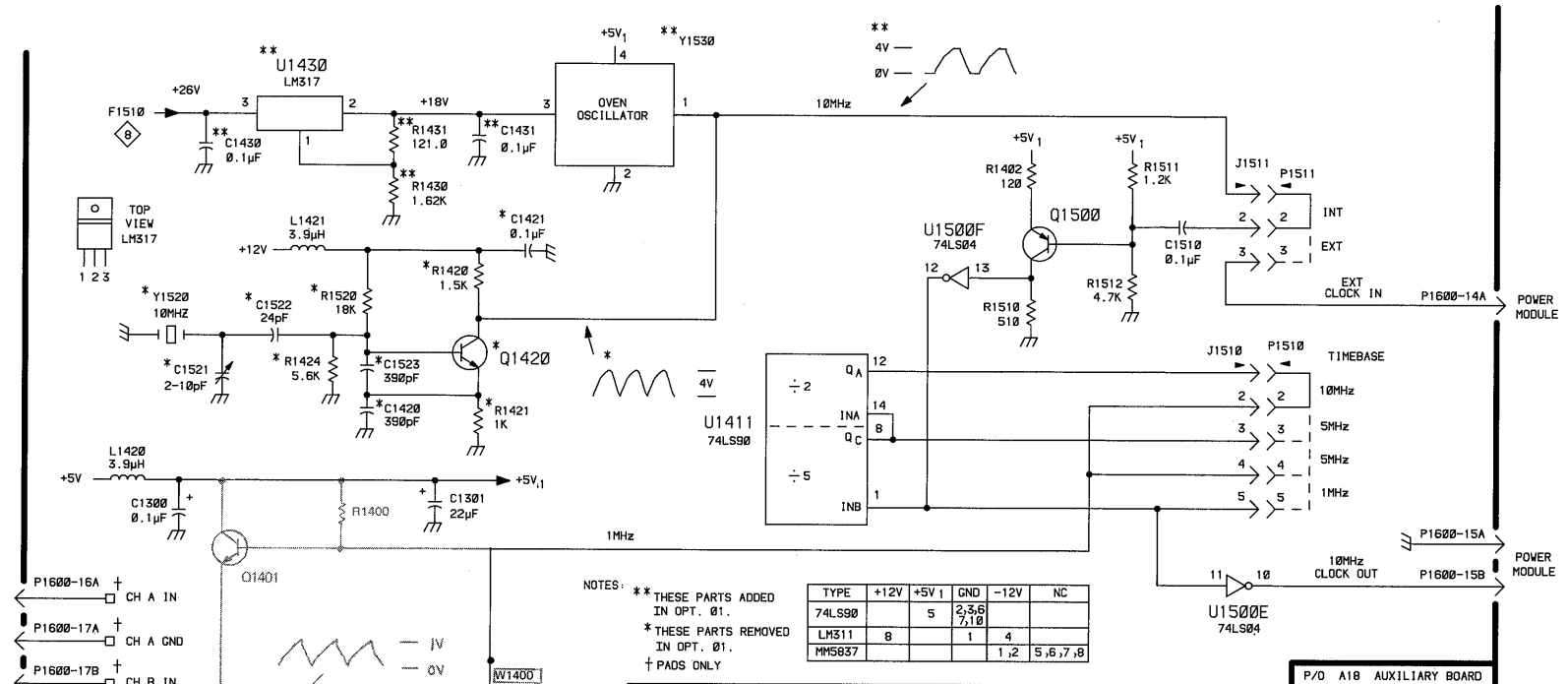
Table 8-7
COMPONENT REFERENCE CHART
(see Fig. 8-12 and 8-14)

COMPONENT REFERENCE
CHART

P/O A12 ASSY			TIME BASE & 320 MHz PLL 5		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1020	H8	B4	R1030	G5	A5
C1021	F7	B4	R1031	H5	A5
C1022	G8	B4	R1032	I5	A5
C1023	G6	B5	R1033	J5	A6
C1024	L8	B4	R1034	J6	A6
C1025	L8	B4	R1035	H5	B5
C1030	I5	A5	R1036	I7	C5
C1031	K6	A6	R1037	K5	B5
C1032	L6	B5	R1122	J8	C4
C1034	M8	B6	R1127	L7	C5
C1120	K7	C5	R1130	K6	C5
C1121	L6	C5	R1131	M9	C5
C1123	L8	C4	R1132	M7	D5
C1130	K7	C5	TP1020	J5	B6
C1131	M8	C6	U1020	G7	B4
CR1130	L5	C6	U1021	F6	B4
Q1130	L7	C5	U1022	H7	C4
R1020	H6	B5	U1030	J6	B5
R1021	H7	C5			
P/O A12 ASSY also shown on			1	2	3
			7	8	
P/O A18 ASSY			TIME BASE & 320 MHz PLL 5		
C1300	B4	H2	R1312*	D6	H2
C1301	D4	H2	R1400*	C4	H2
C1410	D7	J3	R1401	D5	J2
C1411	D5	J2	R1402	G2	K2
C1413*	C5	H2	R1410	C6	J2
C1415*	D5	J2	R1411*	B5	H2
C1420	D3	K4	R1412*	C5	H2
C1421	D2	K4	R1414*	D6	H2
C1430	C1	J4	R1420	D2	K4
C1431	D1	J4	R1421	D3	K4
C1510	H2	K2	R1424	C3	K4
C1521	B3	L4	R1430	D2	J4
C1522	C2	K4	R1431	D1	J4
C1523	D3	L4	R1510	G2	K2
J1510	I3	K2	R1511	H2	K2
J1511	I2	K2	R1512	H2	K2
L1420	B3	J4	R1520	C2	L4
L1421	C2	J3	TP1400	E6	J2
P1510	I3	C3	U1400*	C5	J2
P1511	I2	K2	U1410	C7	J2
Q1300	C7	H2	U1411	F3	K2
Q1401*	C4	H2	U1430	C1	J6
Q1420	D3	K4	U1500	I4	K1
Q1500	H2	K2	U1500	G2	K1
R1310	B6	H2	W1400*	D5	J2
R1311*	D6	H2	Y1520	B2	L4
			Y1530	E1	L5
P/O A18 ASSY also shown on			3	6	7
			8		

A | B | C | D | E | F | G | H | I | J | K | L | M | N

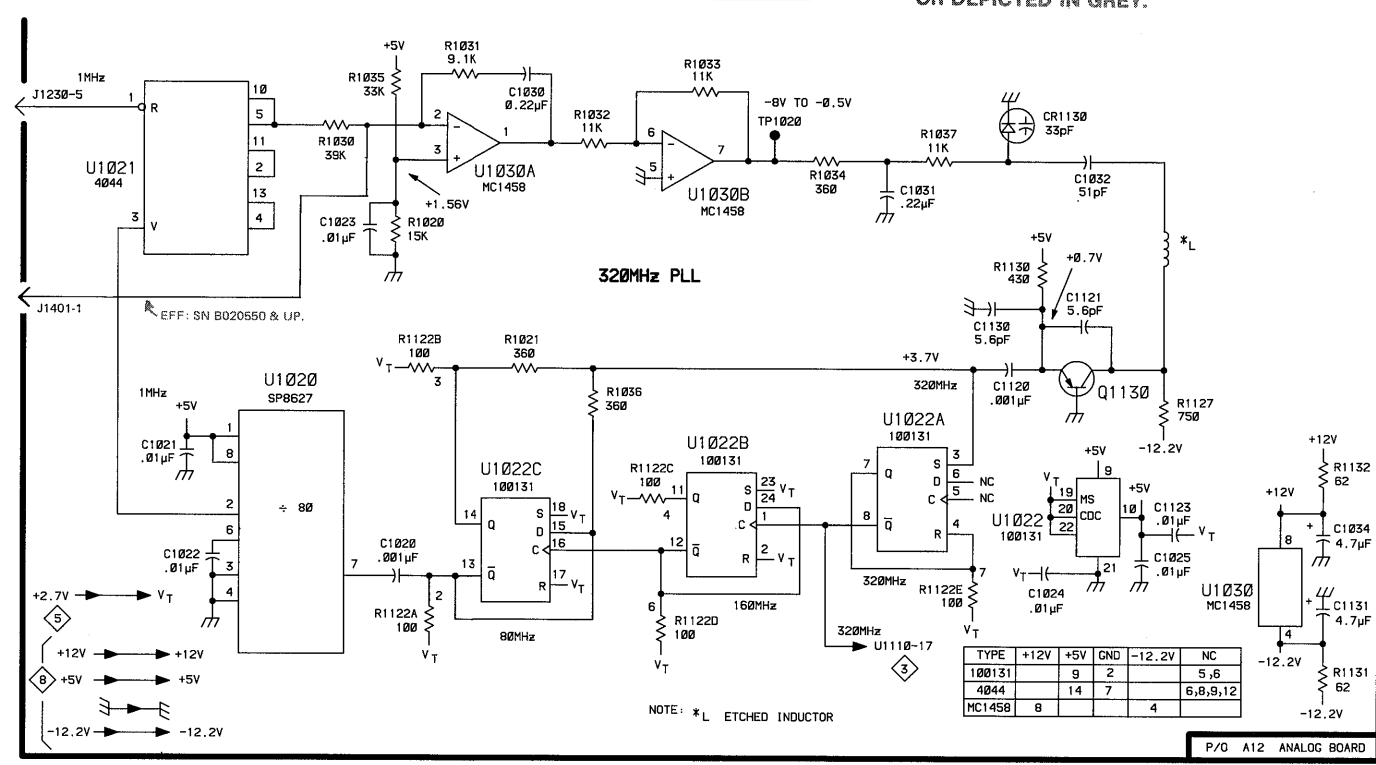
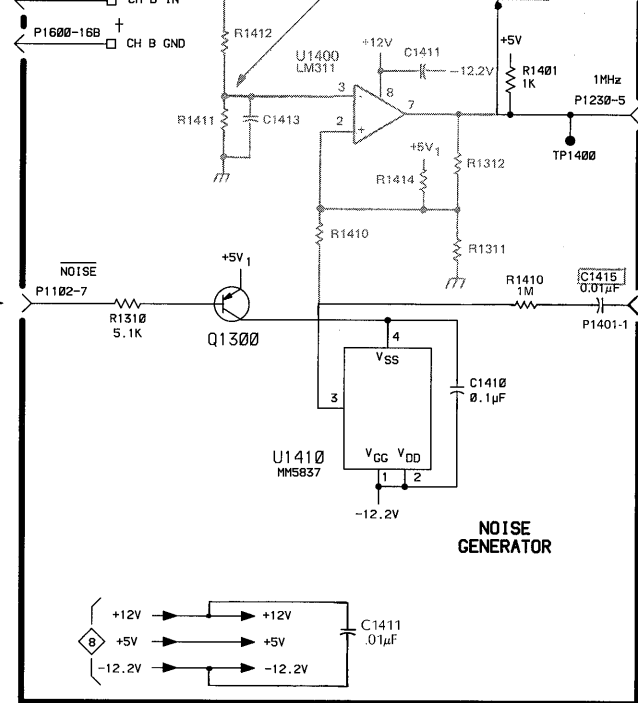
1
2
3
4
5
6
7
8
9



NOTES: ** THESE PARTS ADDED IN OPT. 01.
* THESE PARTS REMOVED IN OPT. 01.
† PADS ONLY

TYPE	+12V	+5V1	GND	-12V	NC
74LS98		5	2,3,6		
LM311	8		1	4	
MM5837				1,2	5,6,7,8

SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN GREY.



Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE

Component Number			
A23	A2	R1234	
Assembly Number	Subassembly Number (if used)	Schematic Circuit Number	

Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

DC 5010

REV DEC 1982
3897-49

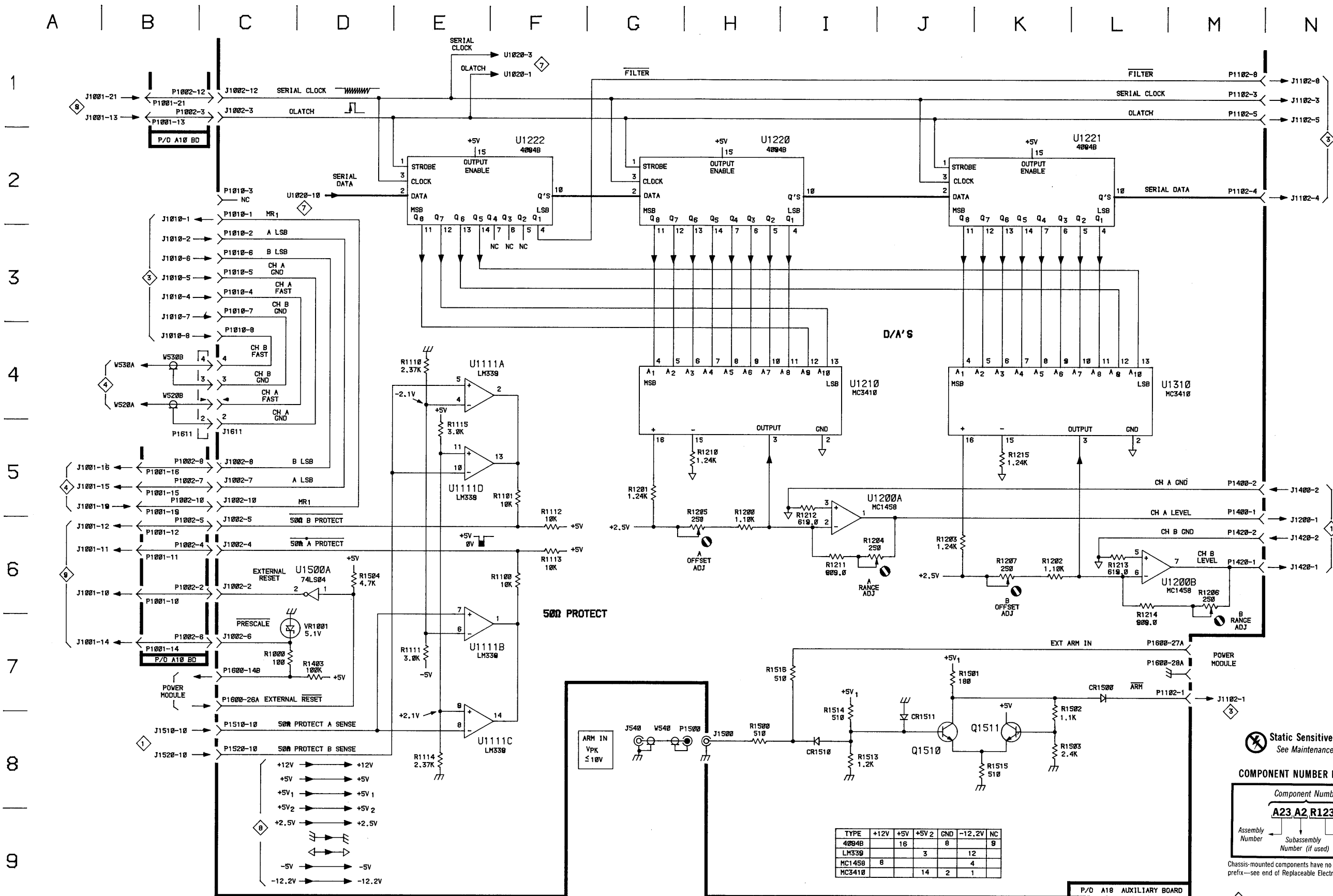
TIME BASE & 320MHz PLL

P/O A12 ANALOG BOARD

5
JCS

Table 8-8
COMPONENT REFERENCE CHART
(see Fig. 8-14)

P/O A18 ASSY			D/A'S, RELAY PROTECT & ARMING 6		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
CR1500	L7	L2	R1206	M6	F1
CR1510	I8	L2	R1207	K6	F1
CR1511	J8	L2	R1210	H5	E2
J1500	H8	L1	R1211	I6	E2
J1611	C5	M3	R1212	I5	E2
J540	G8	Chassis	R1213	L6	F2
P1400	M6	D1	R1214	L6	F2
P1420	M6	D4	R1215	K5	F2
P1500	H8	K1	R1403	D7	J1
P1520	C8	C4	R1500	H8	L2
P1611	B5	M3	R1501	J7	L2
Q1510	J8	L2	R1502	L7	L2
Q1511	K8	L2	R1503	L8	L2
R1000	C7	B2	R1504	D6	L1
R1100	F6	D2	R1513	I8	L2
R1101	F5	D2	R1514	I7	L2
R1110	E4	C2	R1515	K8	L2
R1111	E7	C2	R1516	H7	L3
R1112	F5	D2	U1111	E7	D2
R1113	F6	D2	U1200	J5	E2
R1114	E8	D3	U1210	I4	E2
R1115	E5	D3	U1220	H2	E4
R1200	H5	E2	U1221	L2	E4
R1201	G5	E2	U1222	F2	F4
R1202	K6	F2	U1310	M4	F2
R1203	J6	F2	VR1001	D7	B2
R1204	I6	E1	W520B	B4	Chassis
R1205	H5	E1	W530B	B4	Chassis
			W540	G8	Chassis
P/O A18 ASSY also shown on			3	5	7
			8		



DC 5010

3097-50

D/A'S, 50Ω PROTECT & ARMING

Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE












Component Number	
A23	A2 R1234
Assembly Number	Subassembly Number (if used)
Schematic Circuit Number	

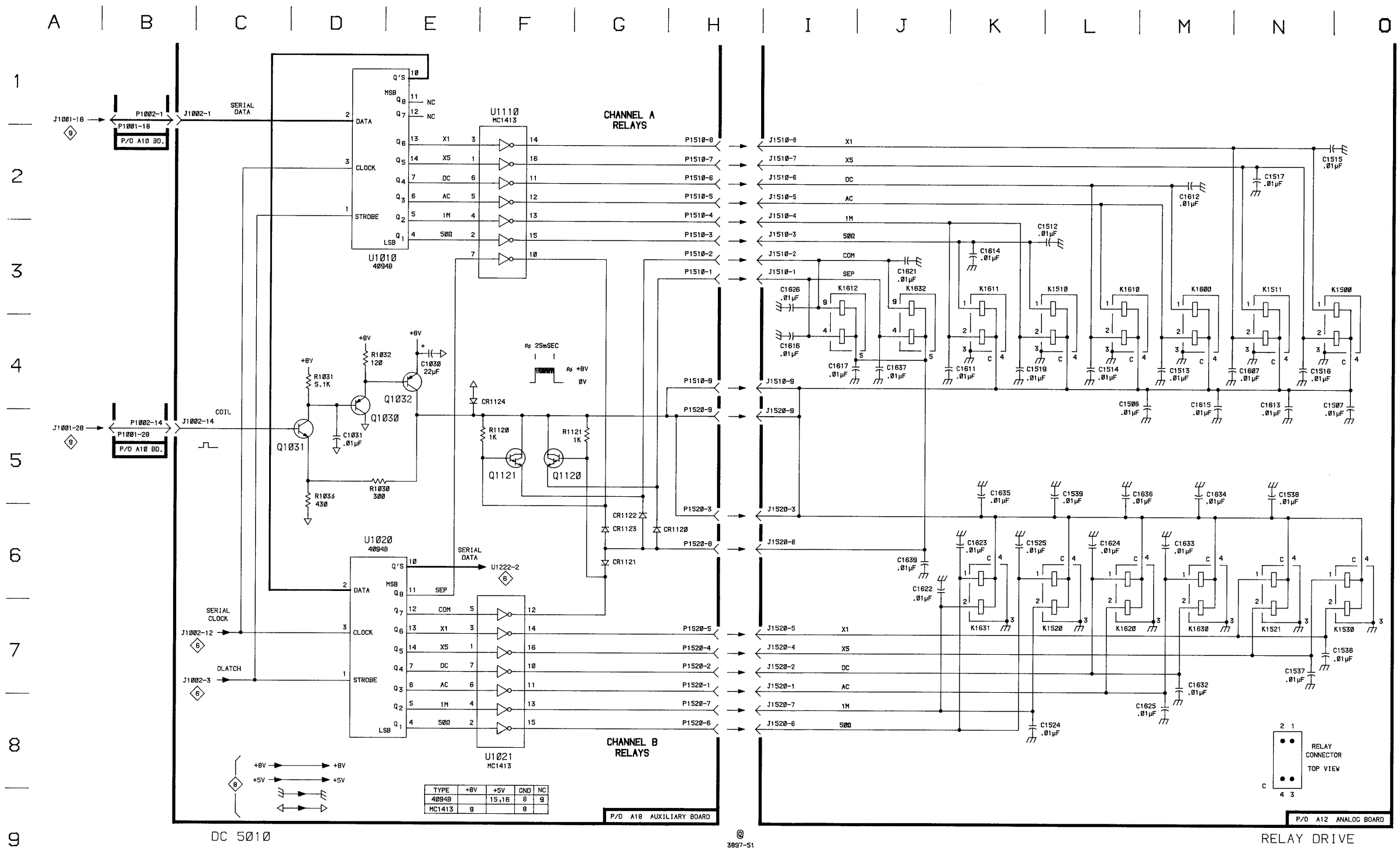
Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

6 JCS

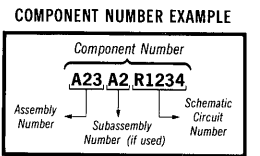
TYPE	+12V	+5V	+5V 2	GND	-12.2V	NC
4094B		16		8		9
LM339			3		12	
MC1458	8				4	
MC3410			14	2	1	

Table 8-9
COMPONENT REFERENCE CHART
(see Fig. 8-12, 8-14 and 8-15)

P/O A12 ASSY			RELAY DRIVE 		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1506	L4	K1	C1625	M8	L4
C1507	O4	K1	C1626	I3	M4
C1512	L3	K3	C1632	M7	L5
C1513	M4	L3	C1633	M6	L5
C1514	L4	L3	C1634	M5	L6
C1515	O2	K2	C1635	K5	M6
C1516	N4	K2	C1636	M5	M6
C1517	N2	L2	C1637	J4	M5
C1519	K4	K3	C1639	J6	N5
C1524	L8	J4			
C1525	K6	J4	J1510	I2	L3
C1536	O7	K5	J1520	I7	L4
C1537	N7	K5			
C1538	N5	L5	K1500	O3	K2
C1539	L5	K5	K1510	L3	K2
C1607	N4	L2	K1511	N3	L2
C1611	K4	M3	K1520	L7	K5
C1612	M2	L2	K1521	N7	L4
C1613	N4	M1	K1530	O7	K5
C1614	K3	L3	K1600	M3	L2
C1615	M4	L3	K1610	L3	M2
C1616	I4	M3	K1611	K3	M2
C1617	I4	M3	K1612	I3	M3
C1621	J3	N3	K1620	L7	M4
C1622	J6	M4	K1630	M7	L5
C1623	K6	M5	K1631	K7	M5
C1624	L6	L4	K1632	J3	M5
P/O A12 ASSY also shown on     					
P/O A18 ASSY			RELAY DRIVE 		
C1030	E4	B6	R1030	D5	B5
C1031	D5	B5	R1031	D4	B5
			R1032	D4	B5
CR1120	H6	C3	R1033	D5	B5
CR1121	G6	C3	R1120	F5	D4
CR1122	G6	D3	R1121	G5	D4
CR1123	G6	D3			
CR1124	F4	D4	U1010	D3	B2
			U1020	D6	B5
Q1030	E5	B5	U1021	F8	C5
Q1031	D5	B5	U1110	F1	C2
Q1032	E4	B5			
Q1120	F5	C4			
Q1121	F5	D4			
P/O A18 ASSY also shown on    					

















Static Sensitive Devices
 See Maintenance Section



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

Table 8-10
COMPONENT REFERENCE CHART
 (see Fig. 8-12, 8-13, and 8-14)

P/O A16 ASSY						POWER SUPPLIES 		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1020	H8	B4	F1820	B6	L5	R1621	D6	K4
C1021	I8	B5	F1821	B8	M5	R1622	C8	K5
C1022	H8	B5				R1718	E6	L4
C1023	I8	B6	L1020	H8	B5	R1719	E6	K4
C1621	C9	K5				R1720	E6	L4
C1721	D6	K5	P1820	A6	N5	R1721	D6	K4
C1722	H8	L5				R1722	C6	K4
C1723	G8	L6	Q1720	D6	K4	R1724	B5	K5
C1810	G6	L4	Q1721	E6	L4	R1725	B9	K5
			Q1722	C6	K4	R1726	E9	K5
CR1020	J8	B6	Q1723	C5	L4	R1727	B8	K5
CR1620	D5	K4				R1728	F8	L5
CR1720	F7	L4	R1022	I7	B6	R1820	F6	M4
CR1721	G8	L5	R1620	C5	K4	R1821	B6	M4
						U1720	D8	K6
P/O A16 ASSY also shown on  								
P/O A12 ASSY						POWER SUPPLIES 		
C1211	K6	E4	C1233	K6	E5	L1221	K6	E4
C1212	K6	E4	C1234	K5	E5	L1230	K3	D5
C1213	K4	E4				L1231	K4	E5
C1220	K4	E4	J1230	K4	E5	L1232	K3	E5
C1221	K3	D4				L1233	K7	E6
C1231	K7	F6	L1120	K4	D4	R1133	K6	D5
			L1220	K4	E4	R1221	K6	E4
P/O A12 ASSY also shown on     								
P/O A18 ASSY						POWER SUPPLIES 		
C1230	H3	F5	J1002	H5	A3	R1323	C4	G5
C1231	H2	F5				R1324	E4	H5
C1232	I2	F5	P1010	K2	M3	R1331	J2	H6
C1310	C2	H3	P1230	J4	H5	R1332	J2	H5
C1320	C4	G4	P1600	A3	N3	R1333	J2	G6
C1321	B4	G5				R1334	J2	G6
C1322	G3	H5	Q1330	G2	F5	R1335	J1	H5
C1324	G1	H4	Q1331	K1	H5	R1413	E1	J3
C1330	I6	G5	Q1332	K2	H6	R1425	F1	H4
C1331	J2	G6	Q1333	J2	H6	R1426	F3	H4
C1332	H6	H5				U1223	H2	F5
CR1232	G3	F5	R1313	B2	G3	U1320	D3	G4
			R1314	B2	H3	U1330	I6	G5
F1510	B1	K3	R1315	C1	H3	U1420	C1	H3
F1511	B3	L3	R1321	B4	F5			
			R1322	B3	G5	VR1410	D1	J3
						VR1411	E2	J3
P/O A18 ASSY also shown on    								

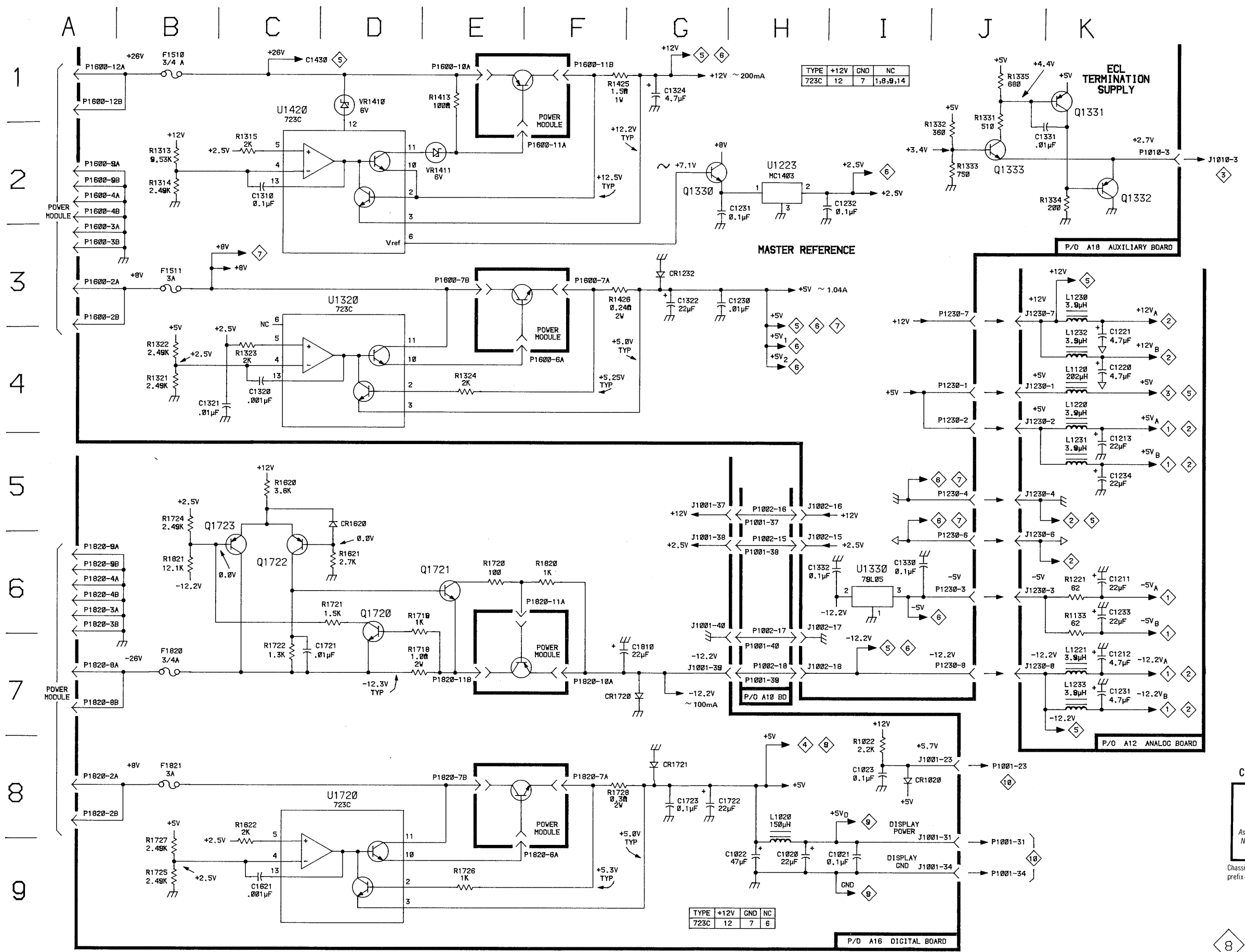



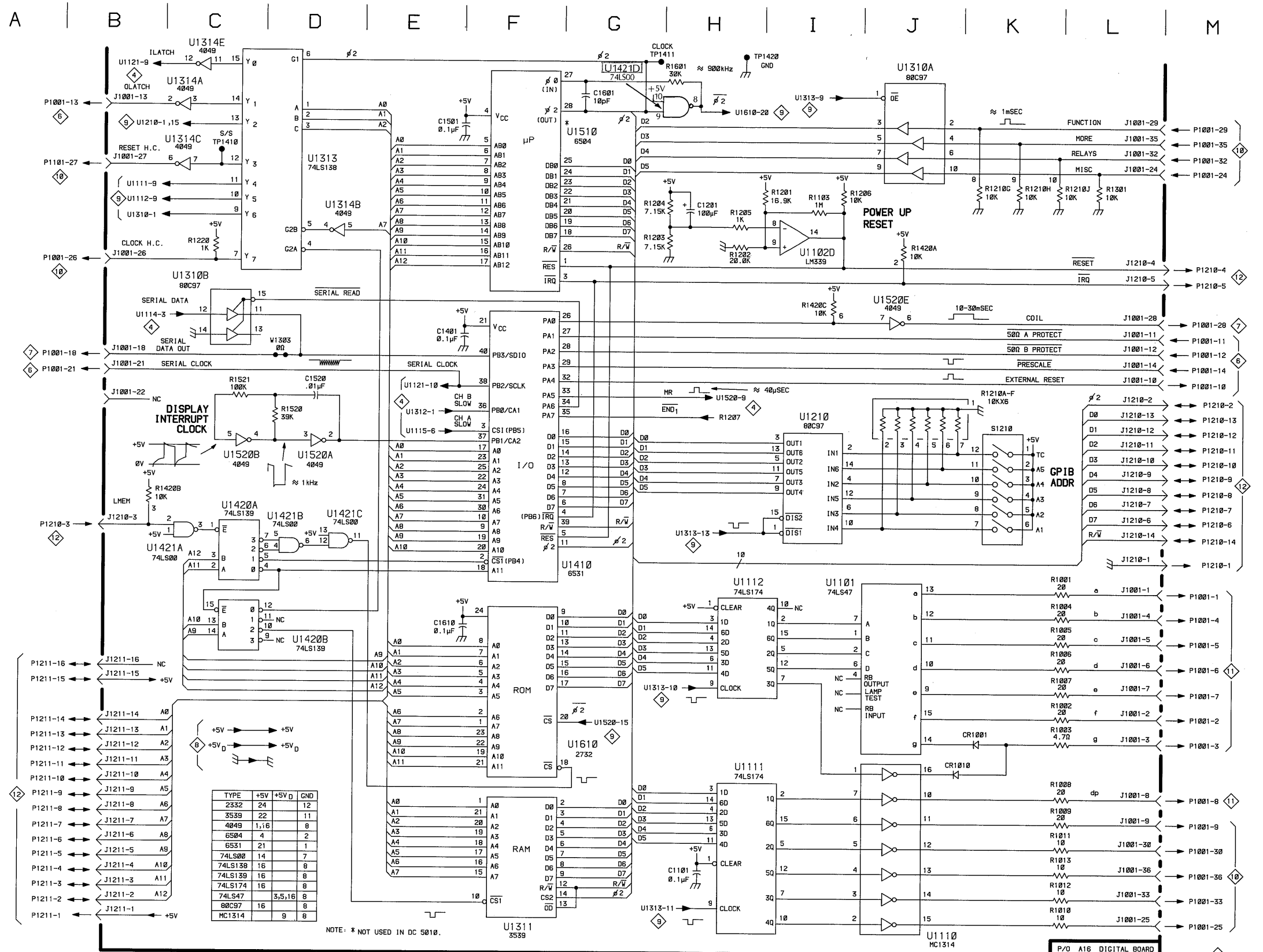


Table 8-11
COMPONENT REFERENCE CHART
(see Fig. 8-13)

P/O A16 ASSY			PROCESSOR AND DISPLAY DRIVERS 		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1101	H9	C2	R1205	H2	D2
C1201	H2	E2	R1206	I2	E1
C1401	E3	G1	R1210	K2	E3
C1501	E1	J1	R1220	C3	E5
C1520	D4	J4	R1301	L2	E2
C1601	G1	J2	R1420	J3	G5
C1610	E6	J4	R1520	D4	J5
			R1521	C4	J5
CR1001	K7	B1	R1601	H1	J2
CR1010	J8	B3			
			S1210	K4	D3
J1001	L7	A3			
J1210	L5	G3	TP1410	C2	G4
J1211	B8	G3	TP1411	G1	G4
			TP1420	I1	F5
R1001	L6	B1			
R1002	L7	B1	U1101	I6	C1
R1003	L7	B1	U1110	J9	C3
R1004	L6	B2	U1111	H8	C3
R1005	L6	B2	U1112	H6	D3
R1006	L7	B2	U1210	I4	E3
R1007	L7	B2	U1310	J1	F3
R1008	L8	B2	U1311	F9	F3
R1009	L8	B2	U1313	D2	F4
R1010	L9	B4	U1314	C1	F5
R1011	L8	B4	U1410	G6	H3
R1012	L9	B4	U1420	C5	G5
R1013	L9	B4	U1421	C6	H5
R1103	I2	D1	U1510	G1	J2
R1201	I2	D1	U1520	D5	H5
R1202	H3	D1	U1610	G7	J3
R1203	G2	D1			
R1204	G2	E1	W1303	D3	E3
P/O A16 ASSY also shown on  					



SEE PARTS LIST FOR EARLIER
VALUES AND SERIAL NUMBER
RANGES OF PARTS OUTLINED
OR DEPICTED IN GREY.

Static Sensitive Devices
See Maintenance Section
COMPONENT NUMBER EXAMPLE

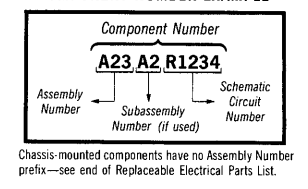
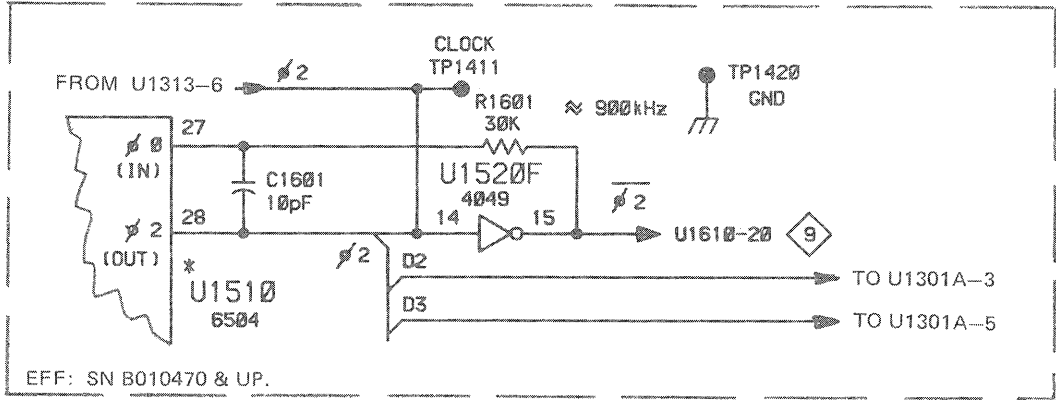


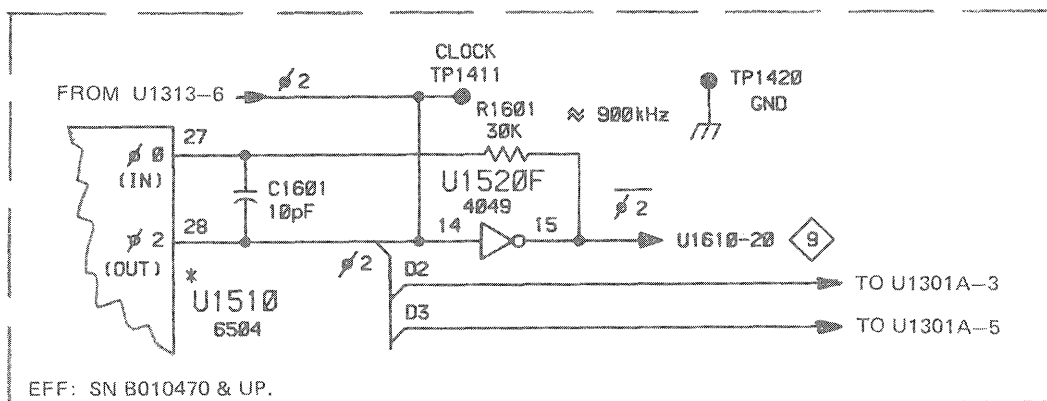
Table 8-12
COMPONENT REFERENCE CHART
(see Fig. 8-15)



COMPONENT REFERENCE
CHART

P/O A10 ASSY			PUSH BUTTONS AND LED's 10		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1321	C1	F3	Q1123	G2	D4
DS1004	I3	C2	Q1124	E3	C4
DS1005	I3	B2	Q1125	F3	C4
DS1104	J3	D2	Q1126	F2	D4
DS1111	L4	C3	Q1127	F2	D4
DS1112	L4	D3	Q1221	G2	E4
DS1113	L5	C3	Q1222	H1	E4
DS1114	L5	D3	R1321	C1	F4
DS1131	L7	C5	S1111	C3	C2
DS1132	L7	D5	S1112	C4	D2
DS1133	L8	C6	S1113	C5	C3
DS1134	L8	D6	S1114	C5	D3
DS1203	J3	E2	S1131	C7	C5
DS1211	I6	E3	S1132	C7	D5
DS1213	J6	E3	S1133	C8	C5
DS1214	I5	E3	S1134	C8	D5
DS1221	K4	E4	S1211	C6	E2
DS1222	K4	E4	S1212	C5	E2
DS1223	K5	E5	S1213	C6	E3
DS1224	K6	E5	S1214	C5	E3
DS1231	K7	E5	S1221	C4	E4
DS1232	K7	E5	S1222	C4	E4
DS1233	K9	E6	S1223	C5	E4
DS1234	K9	E6	S1224	C6	E4
DS1302	K2	G1	S1231	C7	E5
DS1303	L1	G1	S1232	C7	E5
DS1304	L2	G2	S1233	C9	E5
DS1306	K2	F2	S1234	C9	E5
DS1311	I10	F3	S1311	C10	F2
DS1313	I9	F3	S1312	C8	G2
DS1314	I8	G3	S1313	C9	F3
DS1321	J4	F4	S1314	C8	G3
DS1323	J6	F5	S1321	C4	F4
DS1325	I8	G4	S1322	C4	G4
DS1331	J7	F5	S1323	C6	F4
DS1332	J8	G5	S1324	C6	G4
DS1333	J9	F6	S1331	C7	F5
J1321	B1	F4	S1332	C8	G5
J550	B1	Chassis	S1333	C9	F5
P1321	B1	F4	S1334	C9	G5
Q1121	H1	C4	U1121	C2	D4
Q1122	E3	C4			

P/O A10 ASSY also shown on 4 6 8 11



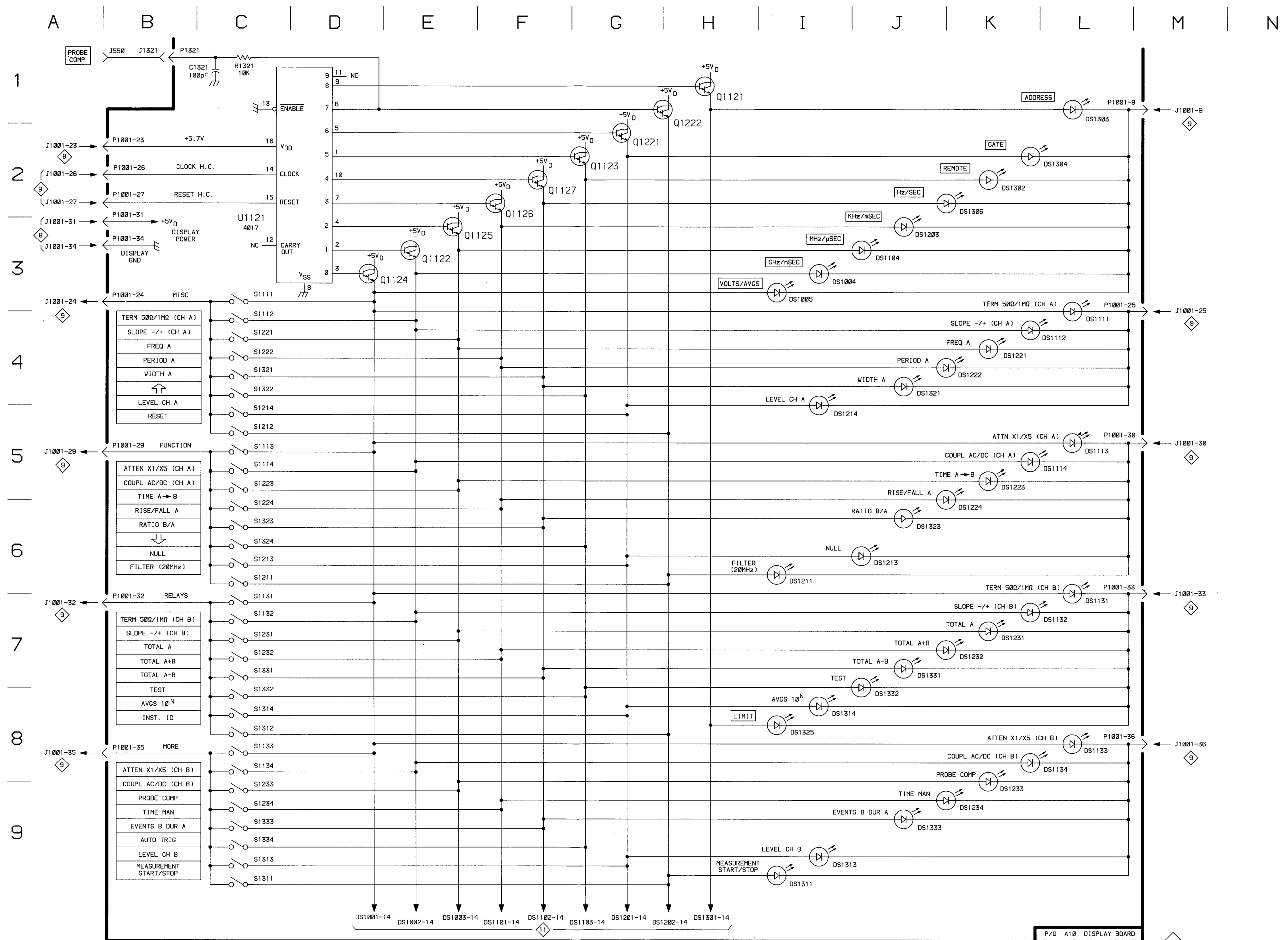







Table 8-13
COMPONENT REFERENCE CHART
(see Fig. 8-15)

P/O A10 ASSY			DISPLAY 		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
DS1001	C5	B1	DS1201	J5	E1
DS1002	D5	B1	DS1202	K5	E1
DS1003	E5	C1	DS1301	L5	F1
DS1101	F5	C1			
DS1102	G5	D1	P1001	B6	G2
DS1103	I5	D1			
P/O A10 ASSY also shown on    					

COMPONENT REFERENCE
CHART

A | B | C | D | E | F | G | H | I | J | K

1

2

3

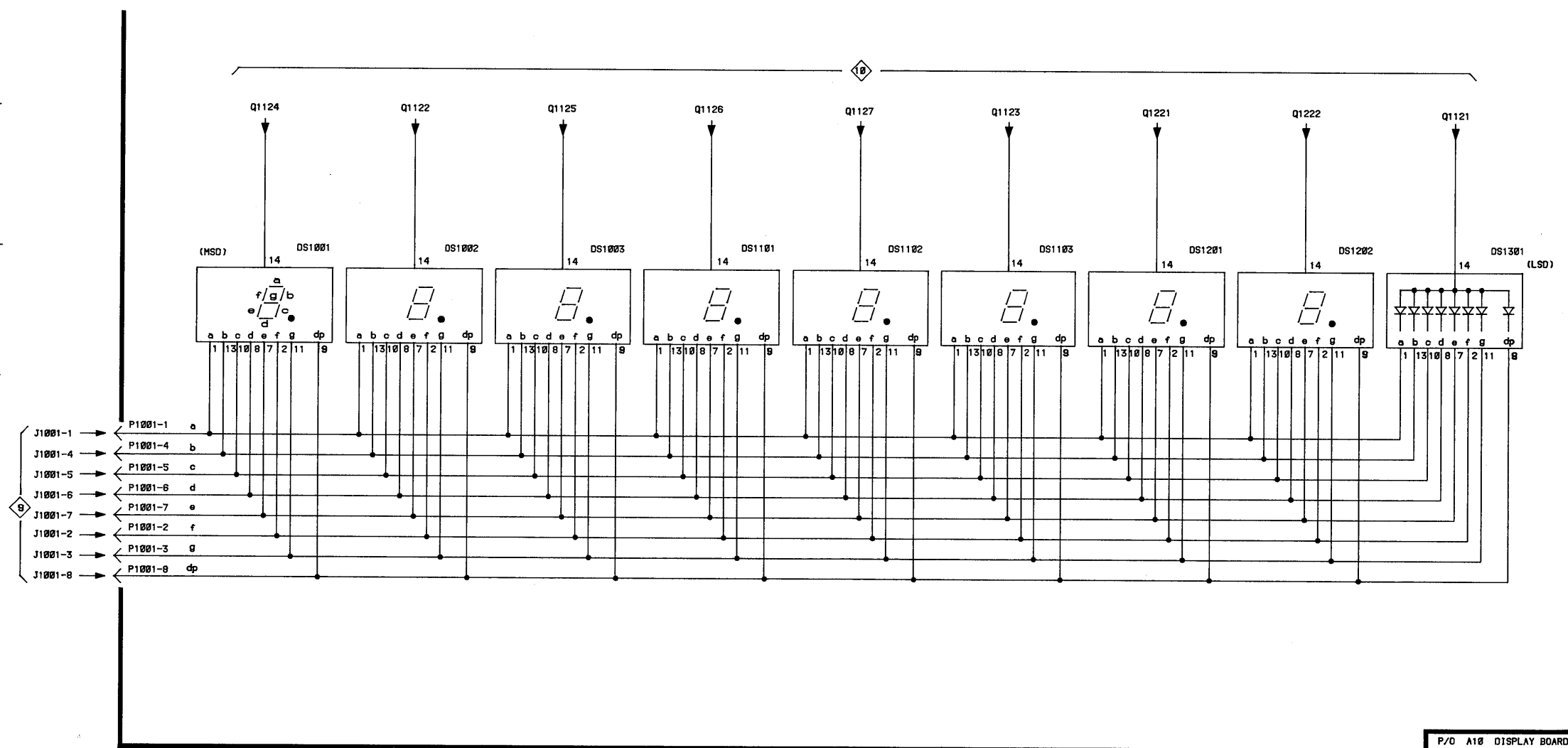
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5

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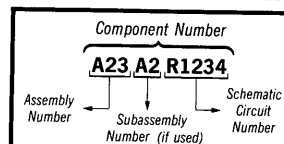
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8



Static Sensitive Devices
See Maintenance Section

COMPONENT NUMBER EXAMPLE



Chassis-mounted components have no Assembly Number prefix—see end of Replaceable Electrical Parts List.

11 JCS

Table 8-14
COMPONENT REFERENCE CHART
(see Fig. 8-16)

P/O A14 ASSY			GPIB PROGRAMMABLE OPTION <div>12</div>		
CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION	CIRCUIT NUMBER	SCHEMATIC LOCATION	BOARD LOCATION
C1001	L5	B2	R1101	K7	D3
C1002	K8	B3	R1210	E5	F5
C1110	I7	C3	R1301	D4	G2
C1201	H1	D1	S1210	D6	F5
C1202	I1	F1			
C1210	G7	F4	U1001	K5	C2
C1301	E2	G1	U1002	K8	C3
C1302	D4	G2	U1101	I6	C2
C1310	L3	G4	U1102	H1	D2
C1311	L2	G5	U1201	J1	E2
P1001	M6	A3	U1210	F1	F3
P1210	B1	G3	U1301	D1	F3
P1210	B2	G3	U1310	G6	F5
P1210	B4	G3	U1311	E8	G5
P1211	B5	H3	U1312	G9	G5
P1211	B6	H3	U1313	F8	G6
P1211	B7	H3			
Q1101	K7	D3			

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

SPECIAL NOTES AND SYMBOLS

X000 Part first added at this serial number
00X Part removed after this serial number

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

```

1 2 3 4 5      Name & Description
Assembly and/or Component
Attaching parts for Assembly and/or Component
    ---*---
Detail Part of Assembly and/or Component
Attaching parts for Detail Part
    ---*---
Parts of Detail Part
Attaching parts for Parts of Detail Part
    ---*---
  
```

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. The separation symbol ---*--- indicates the end of attaching parts.

Attaching parts must be purchased separately, unless otherwise specified.

ITEM NAME

In the Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

ABBREVIATIONS

"	INCH	ELCTRN	ELECTRON	IN	INCH	SE	SINGLE END
#	NUMBER SIZE	ELEC	ELECTRICAL	INCAND	INCANDESCENT	SECT	SECTION
ACTR	ACTUATOR	ELCTLT	ELECTROLYTIC	INSUL	INSULATOR	SEMCOND	SEMICONDUCTOR
ADPTR	ADAPTER	ELEM	ELEMENT	INTL	INTERNAL	SHLD	SHIELD
ALIGN	ALIGNMENT	EPL	ELECTRICAL PARTS LIST	LPHLDR	LAMPHOLDER	SHLDR	SHOULDERED
AL	ALUMINUM	EQPT	EQUIPMENT	MACH	MACHINE	SKT	SOCKET
ASSEM	ASSEMBLED	EXT	EXTERNAL	MECH	MECHANICAL	SL	SLIDE
ASSY	ASSEMBLY	FIL	FILLISTER HEAD	MTG	MOUNTING	SLFLKG	SELF-LOCKING
ATTEN	ATTENUATOR	FLEX	FLEXIBLE	NIP	NIPPLE	SLVG	SLEEVING
AWG	AMERICAN WIRE GAGE	FLH	FLAT HEAD	NON WIRE	NOT WIRE WOUND	SPR	SPRING
BD	BOARD	FLTR	FILTER	OBD	ORDER BY DESCRIPTION	SQ	SQUARE
BRKT	BRACKET	FR	FRAME or FRONT	OD	OUTSIDE DIAMETER	SST	STAINLESS STEEL
BRS	BRASS	FSTNR	FASTENER	OVH	OVAL HEAD	STL	STEEL
BRZ	BRONZE	FT	FOOT	PH BRZ	PHOSPHOR BRONZE	SW	SWITCH
BSHG	BUSHING	FXD	FIXED	PL	PLAIN or PLATE	T	TUBE
CAB	CABINET	GSKT	GASKET	PLSTC	PLASTIC	TERM	TERMINAL
CAP	CAPACITOR	HDL	HANDLE	PN	PART NUMBER	THD	THREAD
CER	CERAMIC	HEX	HEXAGON	PNH	PAN HEAD	THK	THICK
CHAS	CHASSIS	HEX HD	HEXAGONAL HEAD	PWR	POWER	TNSN	TENSION
CKT	CIRCUIT	HEX SOC	HEXAGONAL SOCKET	RCPT	RECEPTACLE	TPG	TAPPING
COMP	COMPOSITION	HLOPS	HELICAL COMPRESSION	RES	RESISTOR	TRH	TRUSS HEAD
CONN	CONNECTOR	HLEXT	HELICAL EXTENSION	RGD	RIGID	V	VOLTAGE
COV	COVER	HV	HIGH VOLTAGE	RLF	RELIEF	VAR	VARIABLE
CPLG	COUPLING	IC	INTEGRATED CIRCUIT	RTNR	RETAINER	W/	WITH
CRT	CATHODE RAY TUBE	ID	INSIDE DIAMETER	SCH	SOCKET HEAD	WSHR	WASHER
DEG	DEGREE	IDNT	IDENTIFICATION	SCOPE	OSCILLOSCOPE	XFMR	TRANSFORMER
DWR	DRAWER	IMPLR	IMPELLER	SCR	SCREW	XSTR	TRANSISTOR

CROSS INDEX—MFR. CODE NUMBER TO MANUFACTURER

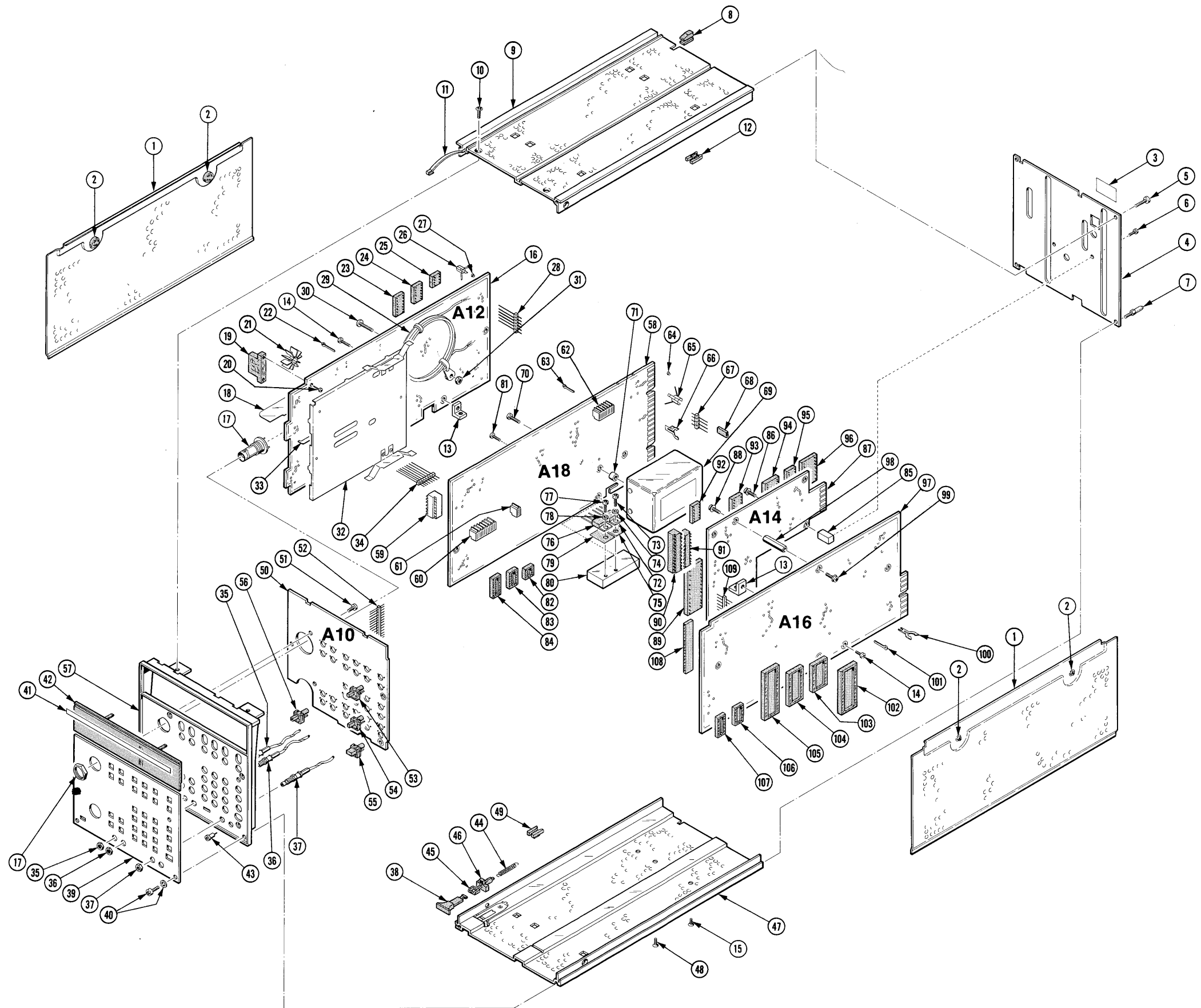
Mfr. Code	Manufacturer	Address	City, State, Zip
000BB	BERQUIST COMPANY	4350 WEST 78TH	MINNEAPOLIS, MN 55435
000BK	STAUFFER SUPPLY	105 SE TAYLOR	PORTLAND, OR 97214
00779	AMP, INC.	P O BOX 3608	HARRISBURG, PA 17105
01536	CAMCAR DIV OF TEXTRON INC. SEMS PRODUCTS UNIT	1818 CHRISTINA ST.	ROCKFORD, IL 61108
05820	WAKEFIELD ENGINEERING, INC.	AUDUBON ROAD	WAKEFIELD, MA 01880
09922	BURNDY CORPORATION	RICHARDS AVENUE	NORWALK, CT 06852
22526	BERG ELECTRONICS, INC.	YOUK EXPRESSWAY	NEW CUMBERLAND, PA 17070
49671	RCA CORPORATION	30 ROCKEFELLER PLAZA	NEW YORK, NY 10020
71279	CAMBRIDGE THERMIONIC CORP.	445 CONCORD AVE.	CAMBRIDGE, MA 02138
71785	TRW, CINCH CONNECTORS	1501 MORSE AVENUE	ELK GROVE VILLAGE, IL 60007
73803	TEXAS INSTRUMENTS, INC., METALLURGICAL MATERIALS DIV.	34 FOREST STREET	ATTLEBORO, MA 02703
80009	TEKTRONIX, INC.	P O BOX 500	BEAVERTON, OR 97077
83385	CENTRAL SCREW CO.	2530 CRESCENT DR.	BROADVIEW, IL 60153
93907	TEXTRON INC. CAMCAR DIV	600 18TH AVE	ROCKFORD, IL 61101

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-1	337-2807-02		2		SHIELD,ELEC:SIDE,PLUG-IN UNIT	80009	337-2807-02
-2	105-0932-00		4		LATCH,PANEL:SIDE	80009	105-0932-00
	214-3364-00		4		FASTENER,LATCH:ACETAL,SIL GRAY	80009	214-3364-00
-3	334-4224-00		1		MARKER,IDENT:GPIB INSTRUCTION	80009	334-4224-00
-4	333-2670-00		1		PANEL,REAR:	80009	333-2670-00
					(ATTACHING PARTS)		
-5	213-0868-00		2		SCREW,TPG,TF:6-32 X 0.375 L,FILM,STEEL	93907	OBD
-6	211-0008-00		1		SCREW,MACHINE:4-40 X 0.250,PNH,STL,CD PL	83385	OBD
	-----		-		(DC5010 ONLY)		
-7	386-3657-01		2		SUPPORT,PLUG IN:	93907	OBD
					- - - * - - -		
-8	214-3089-00		2		LOCKOUT,PLUG-IN:PLASTIC	80009	214-3089-00
-9	426-1801-00		1		FR SECT,PLUG-IN:TOP	80009	426-1801-00
					(ATTACHING PARTS)		
-10	211-0541-00		2		SCREW,MACHINE:6-32 X 0.25"100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-11	214-1061-00		1		SPRING,GROUND:FLAT	80009	214-1061-00
-12	351-0672-00		6		GUIDE CKT BOARD:PLASTIC	80009	351-0672-00
-13	407-2556-00		2		BRACKET,ANGLE:CIRCUIT BOARD,AL	80009	407-2556-00
					(ATTACHING PARTS)		
-14	211-0007-00		2		SCREW,MACHINE:4-40 X 0.188 INCH,PNH STL	83385	OBD
-15	211-0105-00		2		SCREW,MACHINE:4-40 X 0.188,100 DEG,FLH STL	83385	OBD
					- - - * - - -		
-16	-----		1		CKT BOARD ASSY:ANALOG(SEE A12 REPL)		
-17	-----		2		. CONNECTOR,RCPT:(SEE A12J500,J510 REPL)		
-18	337-2850-01		1		. SHIELD,ELEC:CIRCUIT BD W/SPRING	80009	337-2850-01
-19	-----		12		. RELAY,ARMATURE:(SEE A12K1500,K1510,K1511,		
	-----		-		. K1520,K1521,K1530,K1600,K1610,K1611,K1620,		
	-----		-		. K1630,K1631 REPL)		
					(ATTACHING PARTS)		
-20	213-0848-00		24		. SCREW,TPG,TF:0-40 X 0.25,PLASTITE	80009	213-0848-00
					- - - * - - -		
-21	214-1291-00		2		. HEAT SINK,ELEC:XSTR,0.72 OD X 0.375"H	05820	207SB
-22	-----		3		. TERM,TEST POINT:(SEE A12TP1020,TP1310,		
	-----		-		. TP1330 REPL)		
-23	136-0260-02	B010100 B010599X	2		. SKT,PL-IN ELEK:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-24	136-0269-02	B010100 B010599X	1		. SKT,PL-IN ELEK:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-25	136-0514-00	B010100 B010599X	3		. SKT,PL-IN ELEK:MICROCIRCUIT,8 DIP	73803	CS9002-8
	136-0728-00	XB010600	1		. SKT,PL-IN ELEK:MICROCKT,14 CONTACT	09922	DILB14P-108
-26	-----		2		. CONN,RCPT,ELEC:(SEE A12J1130,J1201 REPL)		
-27	136-0252-07		154		. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-28	-----		1		. CONN,RCPT,ELEC:(SEE A12J1010,J1102,J1510,		
	-----		-		. J1520 REPL)		
-29	-----		1		. DELAY LINE,ELEC:(SEE A12J1100,J1101 REPL)		
					(ATTACHING PARTS)		
-30	211-0173-00		1		. SCREW,MACHINE:4-40 X 0.375,FLH,STL	83385	OBD
-31	210-0551-00		1		. NUT,PLAIN,HEX.:4-40 X 0.25 INCH,STL	000BK	OBD
					- - - * - - -		
-32	337-2852-01		1		. SHIELD,ELEC:CIRCUIT BD W/SPRING	80009	337-2852-01
-33	337-2851-00		1		. SHIELD,ELEC:CIRCUIT BOARD	80009	337-2851-00
-34	-----		1		. CONN,RCPT,ELEC:(SEE A12J1230,J1400,		
	-----		-		. J1420 REPL)		
-35	175-3448-00		1		CABLE ASSY,RF:50 OHM COAX,18.0 L,9-2	80009	175-3448-00
	-----		-		(FROM J520 TO A12J1201)		
-36	175-3449-00		1		CABLE ASSY,RF:50 OHM COAX,15.0 L,9-3	80009	175-3449-00
	-----		-		(FROM J530 TO A12J1130)		
-37	175-3450-00		1		CABLE ASSY,RF:50 OHM COAX,14.0 L,9-4	80009	175-3450-00
	-----		-		(FROM J540 TO A18J1500)		
	195-1597-00		1		LEAD,ELECTRICAL:26 AWG,3.5 L,9-1	80009	195-1597-00
	-----		-		(FROM J550 TO A10P1321)		
	352-0171-00		1		. HLDR,TERM CONN:1 WIRE BLACK	80009	352-0171-00
-38	366-1851-00	B010100 B010239	1		KNOB,LATCH:SIL GY,0.625 X 0.25 X 1.09	80009	366-1851-00
	366-1851-01	B010240	1		KNOB,LATCH:IVORY,GY,0.625 X 0.25 X 1.09	80009	366-1851-01
-39	333-2746-00		1		PANEL,FRONT:	80009	333-2746-00
					(ATTACHING PARTS)		
-40	213-0875-00		2		SCR ASSEM WSHR:6-32 X 0.5,TAPTITE,PNH	93907	OBD
	210-1365-00		2		WASHER,FLAT:0.141 ID X 0.5 THK,AL,0.266 OD	80009	210-1365-00
					- - - * - - -		

Replaceable Mechanical Parts—DC 5010

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-41	334-3966-00		1		PLATE,IDENT:	80009	334-3966-00
-42	378-0159-03		1		LENS,LED DSPL:RED W/MARKINGS	80009	378-0159-03
-43	136-0387-00		1		JACK,TIP:GRAY	71279	450-4352-01-0318
-44	214-3143-00		1		SPRING,HLEXT:0.125 OD X 0.545 L, X LOOP	80009	214-3143-00
-45	105-0865-00		1		BAR,LATCH RLSE:	80009	105-0865-00
-46	105-0866-00		1		LATCH,RETAINING:SAFETY	80009	105-0866-00
-47	426-1802-01		1		FR SECT,PLUG-IN:BOTTOM W/SPRING (ATTACHING PARTS)	80009	426-1802-01
-48	211-0105-00		1		SCREW,MACHINE:4-40 X 0.188,100 DEG,FLH STL - - - * - - -	83385	OBD
-49	351-0672-00		3		GUIDE CKT BOARD:PLASTIC	80009	351-0672-00
-50	-----		1		CKT BOARD ASSY:DISPLAY(SEE A10 REPL) (ATTACHING PARTS)		
-51	211-0005-00		4		SCREW,MACHINE:4-40 X 0.125 INCH,PNH STL - - - * - - -	83385	OBD
-52	-----		-		CKT BOARD ASSY INCLUDES:		
-53	-----		1		. TERM SET,PIN:(SEE A10P1001,P1002,P1321 REPL)		
-54	-----		1		. SWITCH,PB ASSY:(SEE A10S1312 REPL)		
-55	-----		3		. ACTR ASSY,PB:(SEE A10S1212,S1322,S1324 REPL)		
-56	-----		1		. ACTR ASSY,PB:(SEE A10S1334 REPL)		
-56	-----		27		. ACTR ASSY,PB:(SEE A10S1111,S1112,S1113, - . S1114,S1131,S1132,S1133,S1134,S1211,S1213, - . S1214,S1221,S1222,S1223,S1224,S1231,S1232, - . S1233,S1234,S1311,S1313,S1314,S1321,S1323, - . S1331,S1332,S1333 REPL)		
-57	386-4581-00		1		SUBPANEL,FRONT:	80009	386-4581-00
-58	-----		1		CKT BOARD ASSY:AUXILIARY(SEE A18 REPL)		
-59	136-0631-00		2		. SOCKET,PLUG-IN:9 PIN FEMALE	00779	1-380949-9
-60	136-0499-10		2		. CONNECTOR,RCPT,:10 CONTACT	00779	4-380949-0
-61	136-0499-02		2		. CONNECTOR,RCPT,:2 CONTACT	00779	3-380949-2
-62	136-0499-08		3		. CONNECTOR,RCPT,:8 CONTACT	00779	30380949-8
-63	-----		1		. TERM TEST POINT:(SEE A18TP1400 REPL)		
-64	136-0252-07		1		. SOCKET,PIN CONN:W/O DIMPLE	22526	75060-012
-65	-----		1		. CONN,RCPT,ELEC:(SEE A18J1500 REPL)		
-66	344-0154-03		4		. CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-03
-67	-----		1		. TERM SET,PIN:(SEE A18J1510,J1511,J1611 REPL)		
-68	131-0993-00		2		. BUS,CONDUCTOR:2 WIRE BLACK	00779	850100-01
-69	-----		1		. OSCILLATOR,RF:(SEE A18Y1530 REPL) - . (OPTION 01 ONLY) (ATTACHING PARTS)		
-70	211-0097-00		2		. SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL - . (OPTION 01 ONLY)	83385	OBD
-71	361-0548-00		2		. SPACER,RING:0.125 ID X 0.25 OD X 0.110 ID - . (OPTION 01 ONLY) - - - * - - -	80009	361-0548-00
-72	-----		1		. MICROCIRCUIT:(SEE A18U1430 REPL) - . (OPTION 01 ONLY) (ATTACHING PARTS)		
-73	211-0097-00		1		. SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL - . (OPTION 01 ONLY)	83385	OBD
-74	210-1178-00		2		. WASHER,SHLDR:U/W TO-220 TRANSISTOR - . (OPTION 01 ONLY)	49671	DF137A
-75	342-0355-00		1		. INSULATOR,PLATE:TRANSISTOR,SILICONE RUBBER - . (OPTION 01 ONLY) - - - * - - -	000BB	7403-09FR-51
-76	-----		1		. TRANSISTOR:(SEE A18Q1332 REPL) (ATTACHING PARTS)		
-77	211-0097-00		1		. SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL	83385	OBD
-78	210-1178-00		1		. WASHER,SHLDR:U/W TO-220 TRANSISTOR	49671	DF137A
-79	342-0355-00		1		. INSULATOR,PLATE:TRANSISTOR,SILICONE RUBBER - - - * - - -	000BB	7403-09FR-51
-80	214-3134-00		1		. HT SK,MICROCKT:TO-220,AL (ATTACHING PARTS)	80009	214-3134-00
-81	211-0097-00		1		. SCREW,MACHINE:4-40 X 0.312 INCH,PNH STL - - - * - - -	83385	OBD

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff Dscont	Qty	1 2 3 4 5	Name & Description	Mfr Code	Mfr Part Number
1-82	136-0514-00	B010100 B010599X	4	.	SKT,PL-IN ELEC:MICROCIRCUIT,8 DIP	73803	CS9002-8
-83	136-0269-02	B010100 B010599X	5	.	SKT,PL-IN ELEC:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-84	136-0260-02	B010100 B010599X	9	.	SKT,PL-IN ELEC:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
	136-0729-00	XB010600	7	.	SKT,PL-IN ELEC:MICROCKT,16 CONTACT	09922	DILB16P-108T
-85	220-0729-00		1		NUT BLOCK:0.25 X 0.471 INCH LONG (ATTACHING PARTS)	80009	220-0729-00
-86	211-0678-00		1		SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL - - - * - - -	01536	OBD
-87	-----		1		CKT BOARD ASSY:GP1B(SEE A14 REPL) (ATTACHING PARTS)		
-88	211-0678-00		2		SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL - - - * - - -	01536	OBD
	-----		-		CKT BOARD ASSY INCLUDES:		
-89	136-0623-00	B010100 B010689	2	.	SOCKET,PLUG-IN:40 DIP,LOW PROFILE	73803	CS9002-40
	136-0757-00	B010690	2	.	SKT,PL-IN ELEC:MICROCKT,40 PIN	09922	DILB40P-108
-90	136-0499-16		1	.	CONNECTOR,RCPT,:16 CONTACT	00779	4-380949-6
-91	136-0499-14		1	.	CONNECTOR,RCPT,:14 CONTACT	00779	4-380949-4
-92	136-0269-02	B010100 B010689X	2	.	SKT,PL-IN ELEC:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-93	136-0621-00	B010100 B010689	1	.	SOCKET,PLUG-IN:22 CONTACT	73803	CS9002-22
	136-0754-00	B010690	1	.	SKT,PL-IN ELEC:MICROCIRCUIT,22 DIP	09922	DILB22P-108
-94	136-0578-00	B010100 B010689	2	.	SKT,PL-IN ELEC:MICROCKT,24 PIN,LOW PROFILE	73803	C S9002-24
	136-0751-00	B010690	2	.	SKT,PL-IN ELEC:MICROCKT,24 PIN	09922	DILB24P108
-95	136-0260-02	B010100 B010689X	2	.	SKT,PL-IN ELEC:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-96	136-0634-00	B010100 B010689	2	.	SOCKET,PLUG-IN:20 LEAD DIP,CKT BD MTG	73803	CS9002-20
	136-0752-00	B010690	2	.	SKT,PL-IN ELEC:MICROCIRCUIT,20 DIP	09922	DILB20P-108
-97	-----		1		CKT BOARD ASSY:DIGITAL(SEE A16 REPL)		
-98	129-0425-00		2	.	SPACER,POST:0.90 L X 0.25HEX (ATTACHING PARTS)	80009	129-0425-00
-99	211-0678-00		2	.	SCR,ASSEM WSHR:4-40 X 0.281 L,PNH STEEL - - - * - - -	01536	OBD
-100	344-0154-03		4	.	CLIP,ELECTRICAL:FUSE,CKT BD MT	80009	344-0154-03
-101	-----		3	.	TERM TEST POINT:(SEE A16TP1410,TP1411, - TP1420 REPL)		
-102	136-0694-00	B010100 B010599	1	.	SKT,PL-IN ELEC:MICROCIRCUIT,28 CONTACT	73803	CS9002-28
	136-0755-00	B010600	1	.	SKT,PL-IN ELEC:MICROCIRCUIT,28 DIP	09922	DILB28P-108
-103	136-0621-00	B010100 B010599	1	.	SOCKET,PLUG-IN:22 CONTACT	73803	CS9002-22
	136-0754-00	B010600	1	.	SKT,PL-IN ELEC:MICROCIRCUIT,22 DIP	09922	DILB22P-108
-104	136-0578-00	B010100 B010599	1	.	SKT,PL-IN ELEC:MICROCKT,24 PIN,LOW PROFILE	73803	C S9002-24
	136-0751-00	B010600	1	.	SKT,PL-IN ELEC:MICROCKT,24 PIN	09922	DILB24P108
-105	136-0623-00	B010100 B010599	1	.	SOCKET,PLUG-IN:40 DIP,LOW PROFILE	73803	CS9002-40
	136-0757-00	B010600	1	.	SKT,PL-IN ELEC:MICROCKT,40 PIN	09922	DILB40P-108
-106	136-0269-02	B010100 B010599X	6	.	SKT,PL-IN ELEC:MICROCIRCUIT,14 DIP,LOW CLE	73803	CS9002-14
-107	136-0260-02	B010100 B010599X	19	.	SKT,PL-IN ELEC:MICROCIRCUIT,16 DIP,LOW CLE	71785	133-51-92-008
-108	-----		2	.	CONNECTOR,RCPT:(SEE A16J1001 REPL)		
-109	-----		1	.	CONN,RCPT,ELEC:(SEE A16J1210,J1211 REPL)		
	198-4522-00		1	.	WIRE SET,ELEC:	80009	198-4522-00
	-----		-	.	(FROM A16 TO A18J1611)		
	352-0162-05		1	.	CONN BODY,PL,EL:4 WIRE GREEN	80009	352-0162-05



REV MAY 1982

DC 5010

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Dscont	Qty	1	2	3	4	5	Name & Description	Mfr Code	Mfr Part Number
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ACCESSORIES

070-3897-01				1						MANUAL,TECH:INSTRUCTION	80009	070-3897-01
070-3553-00				1						MANUAL,TECH:REFERENCE GUIDE	80009	070-3553-00
012-0532-00				1						CABLE,INTCON:50 OHM COAX,42.0 L	80009	012-0532-00

OPTIONAL ACCESSORIES

010-6125-01				1						PROBE,COUNTER:P6125,1.5 METER	80009	010-6125-01
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MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.